Report

Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel I Former Manufacturing Area

77 Lowell Junction Road Site

Andover, MA

DEP RTN 3-0208

Prepared for

Reichhold, Inc.
Research Triangle Park, NC

February 2013

CH2MHILL

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Abbreviations and Acronyms

AUL	Activity and Use Limitation
bgs	below ground surface
ISI	Initial Site Investigation
ISCO	In-Situ Chemical Oxidation
FIR	Final Inspection Report
LSP	Licensed Site Professional
NRS	Numerical Ranking System
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
NSR	No Significant Risk
MNA	Monitored Natural Attenuation
ORC®	Oxygen Release Compound
RAO	Response Action Outcome
RTN	Release Tracking Number

1.0 Introduction

This document has been prepared in support of a Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement for the former Manufacturing Area (FMA) at the Reichhold, Inc. (Reichhold) site (herein after referred to as "the site") located at 77 Lowell Junction Road, Andover, Massachusetts (refer to Exhibit 1-1), and further identified by the Massachusetts Department of Environmental Protection (MADEP) as Release Tracking Number (RTN) 3-0208. The partial RAO is the final of a series of five partial RAO's for the site and thus completes site closure.

The property is approximately 44.7acres based on current survey information and is divided into three Parcels. Exhibit 1-2 provides a site-wide facility plan of the former facility. Parcel I (southwest), estimated at approximately 14.6 acres was the location of the former manufacturing facility (FMA) and a former industrial landfill (LFA). The FMA still contains certain structures (warehouse, office building) as well as footprints for other buildings grandfathered for redevelopment. Parcel II (northwest), estimated at approximately 11.2 acres includes an upland area and a wetland area. The upland area was the location of six former waste lagoons and a concrete equalization basin. No known industrial activities occurred in the wetlands portion of the parcel. Parcel III (northeast), estimated at approximately 18.9 acres, is currently undeveloped and has had no known industrial activity associated with it. The MADEP assigned release tracking number (RTN) 3-0208 for the site and it was later tier classified (a Tier II site) under the Massachusetts Contingency Plan (MCP, 310 CMR 40.000 et seq.). The site is also classified as a Public Involvement Plan (PIP) site (CH2M HILL, 1996).

Remedial activities have been completed and Class A Permanent Solution Partial Response Action Outcome (RAO) Statements have been filed for each of the three parcels, with the exception of the portion of Parcel I that comprises the FMA and is the subject of this filing. The following provides a summary of Partial RAOs previously filed for RTN 3-0208 and identifies the final filing (this document) for the FMA, identified in italics:

Parcel	Partial Response Action Statements
I	Former Landfill Area (LFA) Class A-3 Partial RAO (including AUL) - April 2009.
	Former Manufacturing Area (FMA) Class A-3 Partial RAO (including AUL) – February 2013.
II	Non-wetlands Area Class A-3 Partial RAO (including AUL) - December, 2004.
	Wetlands Area Class A-3 partial RAO (including AUL) - March 2009.
III	Undeveloped Area Class A-2 Permanent Solution Partial-RAO - November 2004.

The FMA is located in the southwest corner of Parcel I adjacent to the Shawsheen River. Use of the approximately 10.6 acre area is conditioned by an Activity and Use Limitation (AUL), contained herein as an attachment. Generally, the AUL permits commercial, industrial, and/or recreational use and allows slab-on-grade building construction utilizing engineered vapor intrusion controls, unless in the Opinion of a LSP these measures are not required to maintain a condition of no significant risk (NSR). The FMA is described by Town of Andover Tax Assessors Map 159, as including portions of Lots 1 through 4. Exhibit 1-3 shows the FMA boundary. Exhibit 1-4, filed with the Essex County (Northern District) Registry of Deeds as Plan PL-16838 at the time of the AUL recording, identifies the boundaries of the AUL, including the detailed metes and bounds.

Attachment A provides a copy of form BWSC104, Response Action Outcome Statement. A human health risk assessment addendum (HHRAA) for the FMA is provided as Attachment B. In accordance with Massachusetts DEP Interim Final Policy WSC/ORS-95-141 (MADEP, 1995), an evaluation of cumulative exposures to residual concentrations present at the entire site comprising the former Reichhold facility is provided in the Risk Evaluation (Section 5) and supporting calculations are provided in Attachment C. This evaluation assessed site-wide risks using data from HHRAAs supporting each of the Partial RAOs, identified above, for each of the different portions of the former Reichhold facility. The overall risk evaluation, including public safety, public welfare, and environmental risk screening is summarized in Section 5 of Attachment B. Attachment D provides a copy of the Activity and Use Limitation (AUL) filed with Essex County (Northern District) Registry of Deeds for the FMA. Attachment E provides data usability evaluations for data supporting this RAO.

2.0 General Site Background and Previous Submittals

2.1 Site History

The site, located at 77 Lowell Junction Road, Andover, Massachusetts, was purchased by Watson Park Company in November 1930. Prior to Watson Park's ownership, the site was known as New England Plywood. The site was purchased by Reichhold from Watson Park in 1953. Reichhold owned the property from 1953 until June 1986 at which point the real property and operation were sold to BTL Specialty Resins Corporation (BTL). At the property, Watson Park, Reichhold and BTL produced phenolic compounds and urea formaldehyde resins in use in many industries.

BTL closed the facility in February 1990 and it has not been in operation since. In September 1996, Reichhold re-acquired the site from BTL for the purpose of facilitating remedial activities under the MCP.

2.2 Summary of Comprehensive Response Actions

The property was first listed in the MADEP's August 1993 Transition List of Confirmed Disposal Sites and Locations to be Investigated (LTBI) on January 15, 1987 and was issued the Release Tracking Number (RTN) 3-0208.

In June 1995, Reichhold retained CH2M HILL to provide licensed site professional (LSP) services for the property, which was then owned by BTL Specialty Resins, Inc. (BTL). Although Reichhold did not own the property at the time, they assumed the lead role in the site remediation process and continued to do so after re-acquiring the site from BTL in 1996. On or before August 2, 1995, a Phase I Initial Site Investigation (ISI) Report, a Numerical Ranking System (NRS) scoresheet, and a Tier Classification Submittal in accordance with the MCP regulations (310 CMR 40.0840, 40.1500 and 40.0500) were submitted to the MADEP on behalf of Reichhold. The Phase I ISI identified three areas of concern: the Equalization Basin Area (EBA), the former Landfill Area (LFA), and the former Manufacturing Area (FMA). In September 1996, subsequent to the Phase I ISI submittal to the MADEP, the property was re-acquired by Reichhold to facilitate remediation activities under the MCP.

The former manufacturing area (FMA) is one of three areas of concern identified at the site. Assessment and remediation activities in two of the areas, the former landfill area (LFA) within Parcel I, and the equalization basin area (EBA) within Parcel II, including non-wetlands and wetlands portions, concluded with the achievement of three separate Class A-3 Partial RAOs (CH2M HILL, 2004e, 2009a, 2009c). Parcel III to the north of the Boston and Maine railroad right of way remained undeveloped open space over the years and was not used by Reichhold to support industrial activities. Assessment activities were concluded there with a Class A-2 Partial RAO (CH2M HILL 2004c). Parcels I and II are zoned Industrial A (IA) and Industrial G (IG), respectively, by the Town of Andover, permitting

most industrial and office uses. They were used for industrial operations between the 1930s and the facility's closure in February, 1990. Parcel III is zoned Single Residence C (SRC).

Beginning in 1997, Reichhold conducted several MCP response actions at the site and continued them through 2006. These included extensive in-situ soil treatment, as well as removal and proper disposal of soils and hardened resins. Structures have also been demolished to provide access to complete soils remediation activities. Soils treatment utilized Oxygen Release Compound (ORC®) and EHC®. During soil excavation/removal activities excavation limits and associated shallow groundwater were treated. In addition, ORC® slurries were injected through temporary infiltration piping and injection points established in backfilled excavations or injection points driven into undisturbed materials to further groundwater treatment. In 2006, in-situ chemical oxidation (ISCO) involving alkaline-activated sodium persulfate was utilized to provide a final treatment of groundwater in key areas of residual impact in the FMA. Intrinsic bioremediation through monitored natural attenuation (MNA) once source areas have been removed and/or treated has been a key component of the remediation strategy.

Detailed information relating to the site assessment and remedial response actions can be found in the following reports:

- CH2M HILL, June, 1995. Phase I – Initial Site Investigation, 77 Lowell Junction Road, Andover, Massachusetts. RTN3-0208.
- CH2MHILL, September, 1996. Public Involvement Plan, 77 Lowell Junction Road, Andover, Massachusetts. RTN3-0208.
- CH2M HILL, August, 1997. Phase II – Comprehensive Site Assessment, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, October, 1997. Phase III – Remedial Action Plan, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, November 1997. Phase IV – Remedy Implementation Plan, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, July, 1999. Well Abandonment Report, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, July, 1999. Phase IV – Final Inspection Report, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, December, 1999. Phase V – Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, June, 2000. Phase IV – Remedy Implementation Plan Addendum, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, July, 2000. Documentation Supporting a Class C Response Action Outcome Statement, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, July, 2000. Phase V – Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, December, 2000. Phase IV – Final Inspection Report Addendum, 77 Lowell Junction Road, Andover, MA. RTN3-0208.

- CH2M HILL, April, 2001. 2000 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, May, 2002. 2001 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, November, 2003. 2002 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, June, 2004. 2003 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2MHILL, June, 2004. Phase IV – Remedy Implementation Plan Addendum, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, December, 2004. Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel II [non-wetland portion], 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, December, 2004. Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel I Former Landfill Area, 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, July, 2005. 2004 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, November, 2005. Phase IV – Final Inspection Report Addendum, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, October, 2006. 2005 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, October, 2007. Post-Class C Response Action Outcome Status Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, January, 2008. January – June 2007 Post-Class C Response Action Outcome Status Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, April, 2008. July – December 2007 Post-Class C Response Action Outcome Status Report, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, June, 2008. Phase IV- Final Inspection Report - Addendum, 77 Lowell Junction Road, MA RTN 3-0208.
- CH2M HILL, July, 2008. Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel I Landfill Area. RTN3-0208.
- CH2M HILL, March, 2009. Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel II [wetland portion], 77 Lowell Junction Road, Andover, MA. RTN3-0208.
- CH2M HILL, April, 2009. Revised Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome Statement – Parcel I Former Landfill Area, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, May, 2009. Confirmatory Amendment to a Notice of Activity Use Limitation (AUL), Parcel I – Former Landfill Area, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, July, 2009. July – December 2008 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, September, 2009. January – June 2009 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.

- CH2M HILL, June, 2010. July – December 2009 Post RAO Operation Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, April, 2011. January – December 2010 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, December, 2011. January – June 2011 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.
- CH2M HILL, March, 2012. July – December 2011 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208.

These reports are available for review at the following locations:

- The Andover Memorial Library, Reference Desk in Andover, Massachusetts
- The Andover Board of Health, Town Offices, Bartlett Street in Andover, Massachusetts

3.0 History of Response Actions - Former Manufacturing Area

Prior to February, 1990, the former manufacturing area (FMA) was operating and producing a variety phenolic and urea formaldehyde resins. A Phase II Comprehensive Site Assessment (CH2M HILL, 1997b) identified several areas of impacted soils and phenolic resins in the FMA exceeding soil remedial action goals for the site. Elevated concentrations of phenols and VOCs were detected in both the soil and groundwater of the FMA. The primary sources of these contaminants were historical releases associated with manufacturing operations. A Phase III Remedial Action Plan (RAP, CH2M HILL, 1997d) and Phase IV Remedy Implementation Plan (RIP, CH2M HILL, 1997e) were developed for the site, including the FMA.

3.1 Source Remediation

The primary goals of the RAP for the FMA consisted of excavation and off-site disposal of contaminated soils /resins, demolition of concrete associated with a former above-ground storage tank (AST) farm, excavation of a 500-gallon concrete sump within the loading dock area of the manufacturing building, excavation of the kettle building sump, and removal of stormwater piping. The Phase IV- Final Inspection Report (CH2M HILL, 1999a) provides specific details of the remediated areas associated with implementation of the Phase IV RIP. In addition, the report describes other demolition activity that was accomplished at the time of soil remediation activities, including demolition of the former kettle building, a storage building, and a small shed. Exhibit 3-1 depicts the general areas that were addressed and more specific drawings of each area are included in the Phase IV FIR (CH2M HILL, 1999a).

Asphalt removal was performed to provide access to contaminated soils for removal and stormwater management facilities for demolition, as well as to enhance natural infiltration of stormwater on site. Excavation, transportation and disposal of impacted media involved a total of 2,649.29 tons of contaminated soils/resins to Waste Management's Crossroads Landfill in Norridgewock, Maine and 975.81 tons of contaminated soils to Environmental Quality's landfill in Wayne, Michigan. In summary, excavation and removal activities involved a loading dock sump (fuel oil impacted soils); an area near a former shed (fuel oil impacted soil); railroad spur area (resins); kettle building area (xylene impacted soils); manufacturing building sump (soils and hardened resins); area near former Tank Farm 4 (soils and hardened resins); area involving styrene-impacted soil near the former manufacturing building; area near Tank Farm 3 (soils and hardened resins); and an area near the former kettle building sump (hardened resins and xylene/ethylbenzene impacted soils).

During excavation and removal of sumps, stormwater piping was removed. If resins were not present, pipes were crushed with other concrete. If resins were present, the piping was disposed of with contaminated soils/resins. Nine catch basins were removed and five were abandoned in place by filling with concrete. Other concrete and brick associated with

demolition were crushed and reused as fill in the area of the former kettle building and the northwest corner of the former landfill. Concrete from the cooling tower was also crushed and reused. Gravel and stone were imported and placed in excavations and compacted.

Due to high levels of contamination encountered in the styrene excavation area and the kettle building sump excavation area, 240 pounds and 800 pounds of ORC® powder, respectively, were applied prior to backfilling of these areas to enhance intrinsic bioremediation by providing an oxygen source. Final restoration of the excavation areas and areas where demolitions had occurred and asphalt had been removed involved placement of a geotextile layer overlain by six inches of 3-inch minus stone.

3.2 Groundwater and Additional Source Remediation

Based on groundwater monitoring, two areas, referred to as the styrene remedial area and the former kettle building remedial area were selected for ORC® treatment (CH2M HILL, 2000d). The styrene remedial area was located near the rear of the former manufacturing building upgradient of CHMW-13 and the former kettle building remedial area was located near monitoring wells GM-6S and CHMW-12. The kettle building had been demolished; however, the manufacturing building was still in place. Exhibit 3-2 and 3-3 illustrate where this work was conducted.

Based on elevated levels of ethylbenzene and styrene detected in monitoring well CHMW-13, it was determined that localized groundwater contamination existing in this area could be addressed with ORC® treatment. To facilitate treatment, one large trench 50′ (wide) x 30′ (long) x 10-15′ (deep) was installed at the rear of the manufacturing building and the trench bottom, including groundwater, was treated with 480 pounds of ORC® powder. At the same time, seven 2-inch injection points (10 feet long with 5 feet of 20 slot screen) were installed across the water table during backfilling of the excavation to facilitate future treatment. The points were set with the screens across approximately 5 feet of the water-table aquifer (CH2M HILL, 2000d). These were subsequently used for treatment 16 months later in 2001 with 900 pounds of an ORC® in a 25% slurry solution (CH2M HILL, 2002).

Groundwater data also showed elevated levels of xylene and ethylbenzene in the groundwater in two separate areas near the former Kettle Building, prompting the monitoring of one existing well (GM-6S) and the installation of a new monitoring well (CHMW-12) to observe the water quality in this part of the site. Based on this information, it was determined that ORC® treatment would be conducted at two sets of paired trenches. These trench pairs were installed in the area of GM-6S and CHMW-12 near the former kettle building. These trenches were 4′ (wide) x 70′ (long) x 10-15′ (deep). The trenches upgradient of CHMW-12 were treated with 630 pounds of ORC® powder. The trenches between CHMW-12 and GM-6S were treated with 420 pounds of ORC® powder. The upgradient trench of each of the pairs was fitted with seven 2-inch injection points (8 feet long with 3 feet of 20 slot screen). The points were set with the screens across approximately 3 feet of the water-table aquifer (CH2M HILL, 2000d). These were subsequently used for treatment 16 months later in 2001 with 210 pounds and 630 pounds of ORC® in a 25% slurry solution(CH2M HILL, 2002). In summary, a total of 1,530 lbs of ORC® powder was applied to the area in 2000 (CH2M HILL, 2000d) and 1,740 lbs applied (in slurry form) in 2001

(CH2M HILL, 2002). Groundwater monitoring continued at the sites after the remediation efforts had been completed.

Further monitoring and investigation suggested an on-going source of ethylbenzene present beneath the former manufacturing building. A recommendation was made to evaluate the feasibility of demolition of the building to facilitate excavation and disposal of contaminated soils (CH2M HILL, 2004a). A Remedy Implementation Plan (RIP, CH2M HILL, 2004b) was developed, including demolition, other abatement activities and well abandonments (CHMW-14 and CHMW-15). This RIP would be undertaken to facilitate excavation, transportation, and disposal of contaminated soils from beneath the former manufacturing building. The excavations would be backfilled and restored following source removal. In addition, continued semi-annual groundwater monitoring would continue in the area.

Demolition activities under the RIP were conducted in June and July of 2004. During these activities, the former manufacturing building, former pump house, and a footbridge across the Shawsheen River near the pump house were demolished (CH2M HILL, 2005c). During the demolition of the concrete slab in the eastern half of the manufacturing building's foundation, a second slab was discovered underneath the first. Resin was encountered in some areas between slabs. Consequently, the concrete was sampled, separated, and 910.44 tons of concrete was removed from this area and transported to Waste Management of New Hampshire's Turnkey landfill for disposal.

Excavation activities were conducted with the objective of removing the source material impacting the FMA groundwater. Following demolition of the former manufacturing building, excavation of contaminated soils was conducted beneath both the former manufacturing building and the former kettle building. In the eastern portion of the excavation area, the depth of excavation was 3 feet, over a 100′ x 30′ area, while the western portion of the area was excavated to 18 in. over a 100′ x 18′ area. Field test kits were utilized to determine excavation limits. Soil was excavated to the water table (approximately 3 ft. bgs). A total of 1,062.48 tons of contaminated soils were removed from the former manufacturing building and kettle building between August and October, 2004 and were disposed at the Waste Management of New Hampshire's Turnkey landfill (CH2M HILL, 2005c).

Approximately 2,250 lbs of O^2-Release EHC® (Adventus) was applied to the base of the excavation areas prior to backfilling. Exhibit 3-4, adapted from the 2005 Phase IV FIR (CH2M HILL, 2005), identifies the location of the manufacturing building and kettle building excavation and treatment areas. EHC® consists of a combination of controlled-release solid carbon and zero-valent iron (ZVI). Approximately 1,650 lbs was applied to the former manufacturing building excavation and 600 lbs to the former kettle building excavation. In addition two rows of injection piping were installed within the former manufacturing building footprint and one row within the former kettle building footprint. This installation would allow for the future application of EHC, if needed.

Approximately 1,200 tons of existing fill located beneath the loading dock slab was moved to backfill the area east of the loading dock. Additionally, 2,400 tons of clean imported

material (dense graded aggregate) was used to complete backfilling of the excavation areas and the depressions left by demolition activities. Non-woven geotextile was laid west of the former manufacturing building over all the areas disturbed by the demolition activities (32,000 sf). 1,100 tons of crushed stone were installed over this geotextile in a layer 6 in. thick.

In March 2006, test-pitting, subsurface soil sampling, and groundwater sampling were conducted in the FMA to identify potential areas of residual contamination and to determine appropriate locations for ISCO application involving alkaline-activated sodium persulfate. Based on this sampling, it was determined that further treatment would be conducted at several locations within the FMA and that post-treatment sampling would be conducted to ascertain the effectiveness of further remediation (CH2M HILL, 2008d). Injection wells and injection points were installed in May/June, 2006, with direct-push technology and injection work completed. Based on a pilot test, further ISCO treatment was conducted. A total of 12,500 lbs of persulfate and 2,250 lbs of sodium hydroxide (for high pH activation) were applied in a 19% aqueous solution over all the locations. Exhibit 3-5 identifies the locations of the probes utilized for ISCO injections. Further details of testing (e.g. radius of influence) are contained in the Phase IV-FIR (CH2M HILL, 2008d). Post-ISCO sampling indicated that groundwater in the area was influenced as far as 62 ft. from the injection zone.

Post-ISCO sampling was conducted in July and October, 2006. Contaminant concentrations detected in the October round of sampling showed a general decrease relative to the July sampling event. The primary COCs, xylene and ethylbenzene, showed a reduction of 88%-99% in 4 of 6 monitoring wells, and a reduction of 55% in the other wells. Overall, the ISCO treatment was shown to be effective.

Since the last groundwater treatment involving ISCO in 2006, groundwater monitoring has been conducted on a semi-annual basis at seven monitoring wells/probe locations within the FMA including GM-2, GM-6S, GP-6, GP-10, GP-11, CHMW-12, and CHMW-13. The monitoring locations are identified in Exhibit 3-6. These results have been presented in the semi-annual operation, maintenance, and monitoring (OMM) reports. Declining concentration trends have been observed for ethylbenzene and xylene in this monitoring network over time. Table 3-1 provides results from these and other wells both pre- and post-ISCO treatment. Downward trends are apparent at all locations. The last OMM report, involving the period July through December 2011 (CH2M HILL, 2012) recommended incorporating existing groundwater data into an updated comprehensive Method 3 risk assessment for the facility and reducing the monitoring frequency from semiannual to an annual monitoring, with the annual event to occur in November. If the risk assessment were to indicate a level of No Significant Risk for the current and foreseeable future has been achieved or could be with an AUL, then a permanent solution response action outcome (RAO) statement would be prepared and monitoring would cease. This RAO presents the findings of the updated risk assessment (refer to Section 5).

4.0 Representativeness Evaluation and Data Usability Assessment

In accordance with 310 CMR 40.1056(2)(k), Response Action Outcome (RAO) Statements are required to include a representativeness evaluation and data usability assessment. The *MCP Representativeness Evaluations and Data Usability Assessments, Policy #WSC-07-350,* (MADEP, 2007) provides guidance for these assessments. The following sections provide a discussion relating to data representativeness and usability supporting the site investigation and closure process.

4.1 Representativeness Evaluation

The Phase II Comprehensive Site Assessment (CSA) investigations for the former Manufacturing Area (FMA) included soil and groundwater sampling. The purpose of the soil sampling was to assess soil quality in the area, provide sufficient data to determine the presence or absence of contamination in specific areas, determine the lateral/vertical extent of contamination, if encountered, and to provide sufficient data to support a site-specific risk characterization. For the FMA, the soil samples specifically targeted areas of concern, including the various former tank farms, the railroad spur area, the former drum storage area, the former gasoline UST area, and the former septic system area. A total of 21 borings were installed within the FMA, and samples were collected. Two test pits were also installed near one of the former tank farms to test the soil quality in that area. Of these installations, 15 borings and the one test pit were sampled for lab analysis, while the other installations were analyzed on site using field techniques. Both shallow (0-3 ft bgs) and deep (> 3 ft bgs) samples were taken. The analyses conducted included VOCs, phenols, and selected metals (cadmium, copper, zinc, iron, lead). Seven of the samples were also analyzed for SVOCs. Three of the samples were analyzed for Resource Conservation Recovery Act (RCRA) 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) along with tests for iron, copper, and zinc. Additional soil data were collected post-remediation activities in 2006, 2007, and 2008. Composite samples of demolished concrete stockpiles were collected in 2007 and 2008.

The CSA groundwater investigations included sampling of a total of 12 wells in the FMA. Eight micro-wells were installed within the FMA to allow for enhanced groundwater sampling. Some of these micro-wells were installed by continuing some of the soil borings already installed in the area. Existing wells that were in good condition were included in the sampling. Each well was sampled once, with the exception of GM-6 and GM-7, which were sampled at both shallow and deep intervals. Analytes included VOCs, phenols, and RCRA 8 metals plus iron, copper, and zinc. Two of the wells were also analyzed for SVOCs.

Seven monitoring wells (CHMW-12, CHMW-13, GM-2, GM-6S, GP-06, GP-10, and GP-11) were monitored over several years and data for the years 2009, 2010, and 2011, including VOCs and individual phenols (through June, 2009). Data for eight other monitoring wells (CHMW-9, GP-03, GP-05, GP-07, GP-08, GP-09, GP-16, GP-17), including VOCs and individual phenols, last monitored in 2006 and 2007 were included in the data-set evaluated in the risk assessment to provide additional areal coverage. This is considered to add an

element of conservatism since intrinsic bioremediation trends since these wells were last monitored is expected to have resulted in further declines in COCs as observed at the other seven wells monitored on a biannual basis.

Surface water and sediment samples were collected from the lower Shawsheen River near the FMA in July 2007 to support the Human Health Risk Assessment Addendum (HHRAA). These were analyzed for VOCs, individual phenols, EPH, VPH, TOC, and Metals (sediment only). Passive diffusion bag (PDB) samplers were utilized in 2011 to collect VOC samples from pore-water beneath the stream-bottom where groundwater from the FMA is discharging to the river. These data were used in the update of the environmental risk screening.

Only laboratory analytical data are used in the risk assessment. The sampling data set for soil, sediment, groundwater, and processed concrete is considered adequate to characterize site conditions, generate the human health risk assessment, and support this RAO filing.

4.2 Data Usability

Field samples included in this assessment were collected in accordance with standard sampling methods, preserved at the site, and delivered to the laboratory within acceptable holding times. All of the data used in support of the risk assessments was generated at fixed qualified analytical laboratories using standard analytical methods which are in accordance with the MADEP Compendium of Analytical Methods (CAM) document (WSC-CAM-VIIA) (MADEP, 2004). Analytical laboratory reports associated with the Phase II investigations (conducted in 1997) were submitted to the MADEP with the Phase II Comprehensive Site Assessment report (CH2M HILL, 1997b). Laboratory reports associated with confirmatory sampling for response actions were submitted to the MADEP with the Phase IV Final Inspection Report (CH2M HILL, 1999a) and addenda (CH2M HILL, 2000d, 2004b, 2005c, 2006b, and 2008d). Analytical laboratory reports for the subsequent groundwater monitoring were submitted to the MADEP with the annual Operating, Maintenance, and Monitoring reports (CH2M HILL 2007, 2008a, 2008b, 2008f, 2009e, 2009f, 2010, 2011a, 2011b, and 2012). The analytical laboratory case narratives have been reviewed by a chemist to confirm quality assurance and quality control compliance with the requirements for “Presumptive Certainty” as described in the MADEP CAM document (MADEP, 2004). The reviewed data reports have been determined to be acceptable for inclusion in the data set. A summary of this review grouped by sampling event is included in Attachment E.

5.0 Risk Evaluation - Former Manufacturing Area

5.1 Human Health Risk Assessment Addendum

Attachment B includes a Human Health Risk Assessment Addendum (HHRAA) as an update to the Human Health Risk Assessment (HHRA) that was prepared for the FMA in 1997 (CH2M HILL, 1997). Initially, the Phase II-CSA (CH2M HILL, 1997) provided a human health risk evaluation, including the FMA. Risks were characterized using Massachusetts DEP Method 3 guidance for current and foreseeable land uses. Attachment B, provides an updated risk evaluation that includes data collected since soils and groundwater remediation have been conducted. The attached addendum also includes a Method 3 risk characterization and concludes that the FMA does not pose any significant risk to human health under the current and expected future land use conditions, with the exception of non-cancer hazards associated with potential exposure to indoor air at future buildings, if no engineered controls limiting vapor intrusion (e.g. vapor barriers and passive sub-slab venting) are used.

Analytical data from the Phase II - CSA (CH2M HILL, 1997), Phase IV- FIR (CH2M HILL, 1999), the 2001 Post-RAO Operations, Maintenance, and Monitoring (OMM) Report (CH2M HILL, 2002), the 2002 Post-RAO OMM Report (CH2M HILL, 2003), the 2006 Post-Class C Response Action Outcome Status Report (CH2M HILL, 2007), and the 2009, 2010, and 2011 OMM Reports (CH2M HILL, 2009d, 2010, 2011a, 2011b, and 2012) were used to develop the HHRAA (Attachment B).

A number of residual chemical constituents were identified during the risk assessment as soil or groundwater COCs in the former FMA; however, xylenes (mixed isomers) and ethylbenzene were considered to be primary COCs. Further details concerning COCs are provided in Attachment B, Section 3. The aquifer below the FMA has been classified as a non-potential drinking water source area (NPDWSA) by DEP.

The expected future use of the former FMA may include recreational uses, municipal storage, or other forms of industrial/commercial development. The HHRAA evaluated potential exposures based on current land use and two reasonably foreseeable future use scenarios: commercial/industrial and recreational. Additionally, potential current and future risks were estimated for recreational exposures in the Shawsheen River reach adjacent to the site. The lower Shawsheen River bisects the former Reichhold property between Parcels I and II and borders the FMA. There are currently no restrictions to recreational access on the Shawsheen River within the vicinity of the Reichhold facility. Some of the potential recreational activities on the lower Shawsheen River include wading, boating and fishing.

An AUL has been placed for the FMA to require that appropriate precautions are implemented to prevent exposure to residual chemical constituents. Specifically, the AUL requires (among other things) that:

- A Soil Management Plan must be developed by a Licensed Site Professional and implemented prior to commencement of any subsurface, utility (with the exception of emergency utility repairs) and/or construction activities that is likely to disturb surface or subsurface soils greater than four (4) inches in depth. The Soil Management Plan should describe appropriate soil excavation, handling, storage, transport, and disposal procedures and include a description of the engineering controls and air monitoring procedures necessary to ensure that workers and receptors in the vicinity are not affected by fugitive dust or particulates. On-site workers must be informed of the requirements of the Soil Management Plan, and the plan must be available on-site throughout the course of the project.

- Applicable worker health and safety practices set forth in 29 CFR 1910, 29 CFR 1926, and the MCP (310 CMR 40.0018) must be followed prior to and during any subsurface, utility and/or construction activities likely to disturb surface or subsurface soils greater than four (4) inches in depth or any activity including removal and/or disturbance of existing pavement or soil containing residual constituents. A Health and Safety Plan must be prepared by a Certified Industrial Hygienist or other qualified individual sufficiently trained in worker health and safety and be implemented prior to the commencement of any activities requiring the plan. The plan should describe the activity and specifically identify the types of personal protective equipment, monitoring devices, and engineering controls necessary to ensure that workers are not exposed to constituents through dermal contact, ingestion, and/or the inhalation of particulate dusts. Workers who may come in contact with soil must be informed of the location of residual constituents and all requirements of the Health and Safety Plan. The plan must be available on-site throughout the course of the project.

- Construction or renovation of buildings in the area may be conducted provided that slab-on-grade design/construction is utilized and includes engineered vapor intrusion controls, unless in the Opinion of a LSP these measures are not required to maintain a condition of No Significant Risk.

Attachment D provides a certified copy of the AUL recorded with the Essex County, Northern District Registry, Book 1333, Page 27 on February 4, 2012.

5.2 Cumulative Risk to Human Health

Over the past several years Human Health Risk Assessments (HHRAs) and Human Health Risk Assessment Addenda (HHRAA) have been prepared for portions of the Reichhold facility, supporting Partial Response Action Outcome (RAO) Statements. The following summarizes the HHRA's and HHRAA's conducted and regulatory status of each area, including the submittal contained herein:

Area	HHRA and HHRAA Method	HHRA Outcome	Regulatory Status
Former Manufacturing Area (FMA)	*Method 3*	*No significant risk (NSR), except potential future indoor air pathway based on groundwater data*	*Current document – Class A-3 RAO (CH2M HILL, 2013)*
Former Equalization Basin Area (EBA) – Upland	Method 3	NSR	Class A-3 RAO (CH2M HILL, 2004b)
Former Landfill Area (LFA)	Method 3	NSR	Class A-3 RAO (CH2M HILL, 2009b)
Former EBA – Wetland	Method 2	NSR	Class A-3 RAO (CH2M HILL, 2009a)
Parcel III	Method 1	NSR	Class A-2 RAO (CH2M HILL, 2004a)

Table 5-1 provides details of exposure scenarios in various HHRAAs for each portion of the Reichhold site and Table 5-2 provides a summary of quantitative risk estimates. The estimated risks for each of the other areas (ie. with the exception of the FMA) are below Massachusetts Department of Environmental Protection [MADEP] cumulative risk limits and it was concluded that each posed “no significant risk (NSR)”.

Section 3.5 of the MADEP guidance document (MADEP, 1995) states “*RAO Statements submitted for a portion of a disposal site may be problematic, as the fundamental risk management criteria of the MCP are expressed as limits on cumulative risk (i.e., the risk to a receptor received from all applicable exposure pathways and all chemicals). Therefore, by breaking up a site into discrete areas and assessing them separately, the cumulative impact of the contamination may not be adequately addressed.*” To address this concern and ensure cumulative risk associated with the former Reichhold facility, as whole, is below the Massachusetts Contingency Plan (MCP) cumulative risk limits (i.e., a cumulative excess lifetime cancer risk [ELCR] no greater than one-in-100,000 and a cumulative hazard index [HI] no greater than 1), the previous HHRAs and associated data were reevaluated and incorporated into the HHRAA (Attachment B).

For a large site where portions have been evaluated separately, the evaluation of cumulative impacts of residual concentrations from the entire site is particularly important when exposure pathways for receptors and/or when the class of chemicals of concern (COCs) identified in an exposure medium are not similar among different portions of the site. The HHRA for one portion of the site would not assess cumulative risks from multiple exposure pathways or multiple classes of contaminants.

As an example, a receptor group may be exposed to groundwater in Parcel A of a site but the same receptor group may be exposed to soil in Parcel B of the site. The cumulative risks from both groundwater and soil exposures by this receptor group at the entire site (both Parcels A and B) could not be assessed in a HHRA for an individual portion of the site alone. Similarly, in the case where a class of contaminants (e.g., pesticides) detected in an exposure medium in Parcel A is different from the class of contaminants (e.g., metals) detected in the same medium in Parcel B and the same exposure pathways exist for the same receptor group, the cumulative risk from exposures to both classes of contaminants in that medium could not be evaluated in the HHRA for only Parcel A.

5.2.1 Approach

An evaluation of cumulative risk, across the site, including other areas previously closed through partial RAO was conducted. In addition, an HHRAA for the FMA alone was prepared (provided in Attachment B).

First, exposure scenarios evaluated for different portions of the Reichhold site were compared. Second, the list of COCs identified for different portions of the site was evaluated to assess whether chemical classes overlap. Third, the cumulative site-wide risks were evaluated quantitatively for the common receptor scenarios identified for the different portions of the site.

Step 1 - Evaluation of Exposure Scenarios

Exposure media and receptor scenarios identified in the HHRAs for the separate portions of the site were compared in the HHRAA to see if a common receptor group was identified and whether the exposure pathways and media evaluated for the receptor group are the same. As presented in Table 5-2, the potential receptor groups identified at the Reichhold site are similar across different portions of the site. Since a Method 1 assessment was used for Parcel III, the specific receptor groups were not discussed, but the expected receptor groups at Parcel III are the same as those identified for other portions of the site (i.e., trespassers and recreators). Although trespassers were identified as potential receptors at the wetland portion of Parcel II, a recreational youth scenario is considered to be a conservative representation of this receptor type (refer to Table 5-3).

Step 2 - Comparisons of COCs

The COCs identified for different portions of the Reichhold site were compared to determine if different classes of chemicals are involved in differing areas. It was concluded that the COCs are similar across the site and are mostly mono-aromatic hydrocarbons, phenols, and metals (Tables 5-4 and 5-5). The highest number of COCs was identified at the FMA and the detected concentrations conservatively represent conditions present at other portions of the Reichhold site for most chemicals.

A similar comparison of detected constituents was performed for groundwater. As presented in Table 5-6, the concentrations and list of detected constituents at the FMA conservatively represent the groundwater conditions at the other portions of the site.

Similar to the observation of soil data, monoaromatic hydrocarbons, phenols, and metals are the majority of constituents detected in site groundwater.

Step 3 - Conservative Estimation of Cumulative Site-wide Risks

To assess whether cumulative site-wide risks are below the MCP cumulative ELCR and HI limits, the site-wide risks were estimated for the four potential receptors commonly identified at the separate portions of the Reichhold site (industrial worker, adult recreator, youth recreator, and construction worker). The following exposure and toxicity information were used to conservatively estimate cumulative site-wide risks:

- Exposure Point Concentrations (EPCs) – The maximum EPCs used in the five HHRAs were used as a conservative estimation of site-wide EPCs (Tables 5-4 and 5-5). Based on the knowledge of historical site uses and remediation conducted, it was thought that potential exposures at the FMA may conservatively represent potential exposures at the different portions of the Reichhold site (i.e., the former LFA, the former EBA, and Parcel III). Tables 5-4 and 5-5 suggest the FMA data provide a conservative representation for most COCs and even when the EPCs at other portion of the site are greater than those at the FMA, the differences were insignificant.

- Toxicity values – The toxicity values identified in the FMA HHRAA were used for the site-wide risk estimates (Exhibits 3-1 through 3-4 of the HHRAA in Attachment B). Four additional chemicals (2-methylphenol, 4,6-dinitro-2-methylphenol, chloromethane, and trichlorofluoromethane) were identified as COCs in the other portions of the site. Therefore, quantitative toxicity values were identified for these four chemicals using the same toxicity information sources (MADEP numerical standard spreadsheets, the United States Environmental Protection Agency's [USEPA] Integrated Risk Information System [IRIS], and USEPA's Provisional Peer-Reviewed Toxicity Values [PPRTVs]), and order of preference are discussed in Section 4 of the FMA HHRAA report in Attachment B. The toxicity values for these additional chemicals are presented in Attachment C, Tables C-1-1 through C-1-4.

- Exposure Factors – The exposure factors identified in the HHRAA were used for the four receptor scenarios identified above (please refer to Exhibit 4-1 of the HHRAA provided in Attachment B). Calculation of volatilization factors is provided in Table C-2-1 in Attachment C.

5.2.2 Results of Cumulative Site-wide Risk Estimates

The ELCR and HI estimates associated with potential site-wide exposures to COCs are summarized below. Detailed calculations for site-wide soil are provided in Attachment C, Tables C-3-1 through C-3-6. The potential ELCRs and HIs estimated for all other media (i.e., groundwater, indoor air, demolished concrete, sediment, surface water, and fish) were obtained from the HHRAA in Attachment B. A summary of the ELCRs and HIs is presented in Table 5-7 and provided below. With the exception of the indoor air pathway under a future scenario, risk and HI estimates are within the MCP limits of 1E-05 for ELCR and HI of 1 for non-cancer effects, see below:

- **Current industrial worker** (soil at FMA and indoor air) - ELCR = 4E-09 and HI = 0.006 for soil; HI = 0.000002 for indoor air.
- **Current/future river recreational user** (sediment, surface water, and fish) – HI = 0.2 (adult) and 0.3 (youth) for all media.
- **Future industrial worker** (site-wide soil; demolished concrete; indoor air) - ELCR = 2E-07 and HI = 0.04 for site-wide soil; ELCR = 7E-10 and HI = 0.006 for demolished concrete; ELCR = 8E-06 and HI = 13 for indoor air, primarily associated with 1,2,4-trimethylbenzene and m/p-xylene.
- **Future construction worker** (site-wide soil; demolished concrete; groundwater) - ELCR = 1E-07 and HI = 0.2 for site-wide soil; ELCR = 1E-10 and HI = 0.04 for demolished concrete; ELCR = 5E-08 and HI = 0.1 for groundwater.
- **Future onsite recreational user** (site-wide soil; demolished concrete; indoor air) - ELCR = 6E-08 (adult) and 2E-08 (youth), and HI = 0.01 (adult) and 0.02 (youth) for site-wide soil; ELCR = 2E-10 (adult) and 6E-11 (youth), HI = 0.002 (adult) and 0.004 (youth) for demolished concrete; ELCR = 8E-06 and HI = 13 for indoor air (risk estimates for future industrial workers were used to conservatively represent risks for future onsite recreational adults and youth).

In summary, cumulative (site-wide) soil and groundwater exposures are within MCP limits for a condition of NSR. The only potential exposure scenario exceeding MCP limits for NSR is inhalation of indoor air in future buildings constructed in the FMA. Cumulative (site-wide) exposures to indoor air were not evaluated due to the existing activity and use limitations (AULs) for the former EBA and former LFA, whereby no structures will be constructed and no uncontrolled invasive activities will be conducted in the future except under the supervision of a Massachusetts-registered Licensed Site Professional (LSP). Based on the risk estimates, the AUL for the FMA includes a term including that no structures will be constructed in the future at the FMA except under the supervision of a Massachusetts-registered LSP. The LSP would review future construction activities and require engineering controls or other remedial actions as necessary, to maintain a condition of NSR, including (as appropriate) use of engineered vapor controls.

5.3 Risk to Public Safety Update

According to the 310 CMR 40.0960, a level of NSR to safety exists if the conditions at the site do not currently (and will not in the foreseeable future) pose a threat of physical harm or bodily injury to people. Such conditions include, but are not limited to the following:

- The presence of rusted or corroded drums or containers, open pits, lagoons, or other dangerous structures
- Any threat of fire or explosion, including the presence of explosive vapors resulting from a release of oil and/or hazardous material
- Any uncontained materials which exhibit the characteristics of corrosivity, reactivity, or flammability described at 310 CMR 40.0347

Portions of the FMA are currently used as an equipment lay-down area. Access to the FMA is restricted by a 8-foot tall chain-link fence topped with barbed wire. Since the site is fenced and there are no site features expected to attract trespassers, the likelihood of trespassers is not significant.

Based on current information and observations, there are no known rusted or corroded drums or containers, USTs, or fuel tanks at the site as these types of items have been addressed by past demolition and removal actions. Site data indicates that none of the VOCs are present at concentrations expected to produce an ignition or explosion threat, nor do they exhibit characteristics of corrosivity, reactivity, or flammability. Therefore, a condition of NSR of harm to safety exists at the site. Reasonably foreseeable future use is expected to involve filling and grading to support development of recreational facilities ensuring no significant future risk of harm to safety.

5.4 Risk to Public Welfare Update

According to 310 CMR 40.994, risk to public welfare for current and reasonably foreseeable site activities and uses is characterized to identify and evaluate nuisance conditions and significant community effects that may be associated with residual contamination or a proposed remedial alternative. This evaluation may involve nuisance conditions such as odors and aesthetics; loss of property value, loss of property use, and other monetary or non-monetary effects not otherwise considered under characterization of risk of harm to health, safety, and the environment but which may accrue due to the degradation of public resources directly attributable to the release or threat of release of OHM. The risk of harm to public welfare is characterized by comparing the concentration of OHM to the UCL in soil and groundwater.

A level of NSR of harm to public welfare has been achieved for current and reasonably foreseeable future conditions if:

- The breathing zone of ambient and indoor air remain free of persistent or noxious odors and accessible drinking water remains free of noxious odors or taste;
- Livestock will remain free from harmful effects;
- No community experiences significant adverse impacts involving monetary and non-monetary factors as identified in 310 CMR 0994(2); and
- The requirements of 310 CMR 40.0996 concerning UCLs for soil and groundwater are met.

Since the manufacturing facility closed in 1990, the operations which created the primary source of environmental releases were discontinued. With remedial actions, contaminant volumes and concentrations at the site have been reduced and will continue to decline further. Future land use may range from open land for soccer fields or similar recreational uses to light commercial or industrial operations.

There were historical complaints from the community in the late 1980s and early 1990s. However, these complaints ceased once Reichhold re-established ownership of the facility and proceeded with active remediation. The decommissioning activities that occurred at the FMA included building demolition, equipment and tank removal, and drum removal.

Extensive soils removal with off-site disposal and in situ soils/groundwater remediation were also conducted.

There are currently no restrictions for recreational activities at the Shawsheen River within the vicinity of the site. Fish consumption advisories have been issued by MADEP for the Shawsheen River within the vicinity of Andover, Massachusetts. The fish consumption advisories have been issued due to the concern that mercury concentrations in fish may pose an unacceptable human health risk (Massachusetts Department of Public Health, 2007). The mercury detected in the Shawsheen River is believed to be related primarily to other anthropogenic sources, including atmospheric fall-out from up-wind coal-fired power plants, documented to have impacted other surface water in Massachusetts and not historic activities that occurred at the FMA or the Reichhold site, generally.

No nuisance conditions are expected in ambient or indoor air. Site groundwater is not a source of drinking water. There are no livestock in the immediate vicinity of the site, and site soil concentrations are below MADEP target risk levels based on industrial and recreational land use scenarios. No significant adverse impacts are expected in the adjacent communities. All EPCs calculated for the COCs in groundwater and soil were below the MADEP's UCLs presented in the MCP Numerical Standards Spreadsheets (MADEP, 2009).

Based on the above information, it is concluded that no significant risk of harm to public welfare exists under current and reasonably foreseeable future conditions.

5.5 Environmental Risk Characterization Update

Characterization of risk of harm to the environment for current and reasonably foreseeable site activities and uses involves assessment of chemical data, migration pathways, and biota and habitats in the vicinity of the disposal site (310 CMR 40.0995). The characterization may consist of two stages, Stage I environmental screening and Stage II environmental risk characterization. Stage I screening, at a minimum, is conducted for all disposal sites evaluated under Method 3 risk characterization. Stage I screening is intended if pathways are complete and warrant a detailed environmental risk characterization (Stage II).

In accordance with 310 CMR 40.0995(3)(a)(2), if no current or future exposure is identified, then a condition of NSR of harm to site biota and habitats may be concluded and a Stage II characterization is not required. Also, if exposure pathways are complete and harm is readily apparent, a Stage II characterization may be redundant and not necessary. Actions would need to be initiated to reach a condition of "no significant risk of harm" before a permanent RAO could be reached. Typically a Stage II environmental risk characterization is conducted for situations involving potentially significant exposures for which it is unclear if a condition of significant risk of harm exists (310 CMR 40.0995 (2)) and detailed evaluation is needed. Environmental receptors to be considered include biota, habitats, wetlands, and sensitive species that would likely be exposed to OHM.

A full Stage II environmental risk characterization was conducted during the Phase II CSA (CH2M HILL, 1997). Areas were identified to be at risk of environmental harm indicating a Stage II should be conducted; however, further analysis during the Stage II indicated they did not represent risk of environmental harm. The site-specific risk analysis included the Shawsheen River, Oxbow wetland (downstream), and upland forest area across the river

from the FMA. One isolated area of potential risk of harm was identified adjacent to a storm-water outfall related to one sediment sample; however, it was concluded that the area was small and does not affect the river's benthic ecosystem. In 2000 surface water sampling was conducted upstream and adjacent to the FMA (CH2M HILL, 2001). No VOCs were detected in either sample. A low concentration of total phenol was detected in the sample adjacent to the FMA but it was concluded that it doesn't pose a significant risk of harm or widespread impact to the river. These sampling stations were sampled again during 2001 and no VOC or total phenol was detected at either location (CH2M HILL, 2002). Recommendations were made to confirm these results with sampling at the same stations in 2002. The results from 2002 sampling confirmed no detection of VOCs or phenol (CH2M HILL, 2003) suggesting the site is not adversely impacting Shawsheen River water quality. Sampling conducted in 2003 confirmed 2001 and 2002 results (CH2M HILL, 2004a). Groundwater became the focus of monitoring for the FMA in subsequent years.

In June 2007, additional sediment and surface water sampling was conducted at three stations to support risk assessment (CH2M HILL, 2008a). A background sample location was established upstream (SW1/SD1-UPST) and two locations were established adjacent to the FMA (SW2/SED2-CH12 and SW3/SED3-CH13). These two locations were positioned down gradient from monitoring wells CHMW-12 and CHMW-13 where shallow groundwater from the vicinity of these monitoring wells would be expected to discharge to surface water (CH2M HILL, 2008a). These two monitoring wells have been key locations over time for monitoring progress of intrinsic bioremediation of groundwater, particularly for xylene and ethylbenzene, following remediation involving soils removals and soils/groundwater treatments with ORC®, EHC®, and sodium persulfate, all of which were completed by June, 2006 (refer to Section 3 for a remediation summary).

Surface water samples were non-detect for VOCs, individual phenols, EPH, and VPH fractions, except for a p/m xylene detect at SW2-CH12 at 1.1 μg/L. Sediment samples collected at the SED2-CH12 and SED3-CH13 locations did detect a variety of VOCs, including ethylbenzene, o-xylene, and p/m-xylene. SVOCs were non-detect except fluoranthene at SED2-CH12. EPH fractions were non-detect in all samples and VPH fractions were only detected at SED2-CH12. Additional sediment sampling was recommended for future OMM events along with continued groundwater monitoring semiannually to continue to assess the enhanced intrinsic bioremediation from the application of oxidizing compounds (CH2M HILL, 2008a). Groundwater monitoring continued from the second half of 2007 through 2010 at seven (7) key wells, documenting continuing downward trends in VOC constituents at the FMA. Ethylbenzene dropped below the Method 1 GW-3 standard of 5000 μg/L, protective of surface water, at its last location (CHMW-13) following the October, 2009 sampling event and all monitoring wells have remained below the standard since that time. All monitoring wells, including CHMW-12, dropped below the Method 1 GW-3 standard for total xylenes (mixed isomers) following the May, 2007 sampling event. A recommendation to discontinue individual phenol analysis during OMM events was made following the January-June, 2009 OMM report (CH2M HILL, 2009f) due to non-detects for individual phenols at all locations with the exception of 2,4 dimethylphenol which was detected at 17 μg/L or less at two locations. The Method 1 GW-3 standard for this constituent is 50,000 μg/L.

During 2011, the surface water/sediment sampling locations from 2007 were revisited for the collection of pore-water with passive diffusion bag (PDB) samplers. Pore-water was collected to further evaluate intrinsic remediation and potential impacts to benthic habitat along the Shawsheen River, where potentially impacted FMA groundwater is discharging. These results are discussed in the July-December, 2011 OMM report (CH2M HILL, 2012) and summarized are below.

Table 5-8 provides a summary of PDB sampling results from groundwater (pore-water) six inches beneath the streambed of the Shawsheen River adjacent to the FMA. The first event in June, 2011 evaluated pore-water at the same locations where sediment and surface water samples had been collected in 2007 (CH2M HILL, 2008a). These results confirm impacts to benthic sediments in the vicinity of SEDPDB-2 identified in the 2007. The second event from November, 2011 provides further delineation of the area around SEDPDB-2 and evaluates an approximately 560 square foot area in the vicinity. This includes pore-water near the bank and 10 feet offshore along a reach of the river including area both upstream and downstream of SEDPDB-2 and measuring 56 feet in length. Exhibit 3-6 depicts the locations of these monitoring points.

All results at SEDPDB-1 were non-detect (ND) for VOCs. Low concentrations of chlorobenzene; 1,4 dichlorobenzene; and isopropylbenzene, were detected at SEDPDB-3 below both the "lowest ecologically-based criteria" (described in Table 5-8) and Method 1 GW-3 values. At SEDPDB-2, downstream, pore-water results indicated impact by site-related contaminants. These results were consistent with the findings of sediment/surface water sampling conducted at this location in 2007 (CH2M HILL, 2008). Xylene (mixed isomers) was detected at 7064 µg/L, the only constituent greater than the Method 1 GW-3 standard (5,000 µg/L for xylene – mixed isomers). Ethylbenzene at 1430 µg/L exceeded the "lowest ecologically-based criteria" used in the development of the Method 1 GW-3 standards but not the standard itself which accounts for both attenuation in groundwater and dilution in surface water.

A second pore-water sampling event was conducted in November, 2011, providing further characterization of pore-water in the vicinity of SED-PDB-2. SED-PDB-UG1 (10 feet upstream) and SED-PDB-CG (10 feet offshore) were both non-detect for VOCs. SED-PDB-2 contained similar VOCs to the July event but at lower concentrations, none exceeding either the Method 1 GW-3 values or "lowest ecologically-based criteria". SED-PDB-DG-1, 20 feet downstream had concentrations similar to SED-PDB-2 in July with xylene (mixed isomers) at a concentration of 7170 µg/L, the only constituent detected at a value greater than the Method 1 GW-3 standard. Ethylbenzene at a concentration of 1310 µg/L exceeds the "lowest ecologically-based criteria" used to derive the Method 1 GW-3 standard but not the standard itself. A sample collected 45 feet downstream of SED-PDB-2 was non-detect for most VOCs and had very low concentrations of xylene (mixed isomers) and ethylbenzene at 24 µg/L and 3.7 µg/L, respectively. Both of these values are well below the "lowest ecologically-based criteria" and Method 1 GW-3 standards.

This pore-water monitoring work suggests a defined zone where impacted groundwater from the FMA is discharging. Concentrations of xylene (mixed isomers) and ethylbenzene detected in pore-water monitoring are comparable to those observed in FMA monitoring wells CHMW-12 and GP-06 in 2007 following initial ISCO treatment. Xylene (mixed isomers) is the only constituent exceeding the Method 1 GW-3 standard of 5000 µg/L at

SEDPDB-2 with a concentration of 7064 µg/L observed in July and at SED-PDB-DG1 with a concentration of 7170 µg/L observed in November. Groundwater concentrations of xylene (mixed isomers) and ethylbenzene have been declining over the past several years at the FMA. Consequently, it is expected that pore-water values in proximity to the Shawsheen River will also decline in future years as natural attenuation processes and natural restoration continue.

In November 2011, pore-water was monitored over an area measuring 10 feet across by 56 feet long in proximity to SED-PDB-2. The data suggest that groundwater discharge occurs in shallow water adjacent to the stream bank. A sampler was installed 10 feet offshore from SED-PDB-2 to evaluate potential discharge in deeper water. The results were non-detect for VOCs. Due to deep river cross-sections along this reach, samplers could not be installed 10 feet off-shore opposite each of the shallow locations, as had been planned. However, it is expected that most groundwater to surface water flux occurs in close proximity to the shoreline because of the shallow depth of groundwater. It is expected that the relationship between SED-PDB-2 and SED-PDB-CG (10 feet offshore) is the case at the other locations along the shoreline (ie. the offshore location would be expected to be ND).

Higher static water in the Shawsheen in November compared with July likely causes the observed shift in groundwater discharge downstream. This is indicated by the contaminant fingerprint detected for SED-PDB-DG1 when compared with data from the SEDPDB-2 location in July. SED-PDB-UG1 (upstream) and SED-PDB-DG2 (downstream) bracket the area of discharge of impacted groundwater. If it is conservatively assumed that discharge of impacted groundwater extends the full length and width of the monitored reach, then an approximately 560 square foot area is potentially receiving impacted groundwater (see Exhibit 3-6).

In accordance with MADEP technical guidance for ecological risk assessment entitled, *Area-Based Screening for Sediment Contamination* (MADEP, 2006), this area of porewater and associated sediment/benthic impact may be eliminated from an ecological risk assessment if the area is less than 1000 square feet, it does not extend more than 50% of the width of the river, and does not extend more than 500 lineal feet along the length of the river. As stated in the guidance, "DEP recommends area-based screening of sites with sediment contamination so that sites with a small area of sediment contamination that is unlikely to pose a significant risk of harm to the environment are eliminated from the risk assessment (MADEP, 2006)". Xylene, ethylbenzene, and the other site-related VOC's tend to degrade readily under aerobic conditions expected with groundwater discharge to surface water.

Since bioaccumulation and persistence is unlikely to occur for these volatile compounds, and, considering the small area of impact, significant risk of harm to higher trophic level receptors is similarly unlikely. There are also no known species of special concern, threatened, or endangered species (310 40.0922(3)) identified by MassGIS along the Shawsheen River near the FMA. In accordance with 310 CMR 40.0995, the FMA is determined to have no significant risk of harm to biota or habitats and further Stage II evaluation based on new data since the Phase II CSA (CH2M HILL, 1997) is not necessary. VOC impacts that are localized along the Shawsheen are expected to diminish over time as intrinsic bioremediation of groundwater continues. Based on the data and evaluation discussed above, it is concluded that a condition of no significant risk of harm to the environment is established for the sediment contamination associated with the site.

6.0 Feasibility of Achieving Background - Former Manufacturing Area (FMA)

In accordance with 310 CMR 40.0860, the feasibility of achieving or approaching background levels of OHM shall be evaluated for all disposal sites where remedial actions have been undertaken to achieve a Class A RAO. For the FMA, the feasibility of achieving background was evaluated in accordance with MADEP Policy #WSC-04-160, *Conducting Feasibility Evaluations under the MCP* (MADEP, 2004).

The primary COCs associated with the former industrial operations at the FMA have been ethylbenzene, xylenes (mixed isomers), chlorobenzene, and other related VOCs in soil and groundwater. These constituents have been degrading through enhanced intrinsic bioremediation following response actions involving soil (source) removals and ORC®, EHC®, and ISCO (alkaline-activated sodium persulfate) in-situ treatments of soil and groundwater. For non-persistent contaminants such as the residual VOCs present at the FMA, the policy states that achieving or approaching background may be deemed infeasible. Essentially, the benefits of additional remedial actions to achieve or approach background may not be justified for residual contaminants that degrade well through natural processes. Therefore, non-persistent contaminants may be eliminated from the feasibility evaluation.

Data utilized in the HHRAA were evaluated to assess the feasibility of achieving or approaching background for persistent contaminants. Comparing maximum values for COCs in groundwater, provided in Exhibit 2-5 of the HHRAA (Attachment B), against Method 1 GW-3 Standards indicates that all groundwater COCs, both persistent and non-persistent, are less than half the standard, with the exception ethylbenzene, xylenes (mixed isomers), and chlorobenzene. These three non-persistent constituents may be eliminated from the feasibility evaluation as indicated above. In accordance with MADEP Policy #WSC-04-160 (MADEP, 2004), background for the persistent contaminants is considered to be "approached" for groundwater at the FMA since concentrations of each persistent contaminant at each exposure point are below ½ the applicable Method 1 groundwater standards as specified in 310 CMR 40.0900.

Portions of the FMA are currently leased by a crane and rigging company for equipment storage and lay-down. Workers and a site security guard may be present on an intermittent basis. Therefore, FMA site soils are considered category S-2 (adult receptors present, low-to-high frequency, low intensity of use, and accessible). Under potential future industrial/commercial site use, FMA soils are considered category S-2 (adult receptors present, high frequency, low intensity exposure, and accessible). The HHRAA (Attachment B) conservatively considers site surface soils under potential future recreational use, to be category S-1 (potential child receptors present, high frequency, high intensity exposure, and accessible). This is considered a conservative assumption since recreational redevelopment of the property to high frequency, high intensity uses would likely require considerable additional clean fill cover to bring the FMA grades to similar elevations as adjoining areas. Currently accessible surficial soils would become inaccessible.

As part of the background feasibility evaluation for soil, HHRAA maximum concentration data for the 0-2 foot interval, summarized in Attachment B, Exhibit 2-1, were screened against Method 1 S-1/GW-3 soil standards according to Policy #WSC-04-160, Section 9.3.3.2. The concentrations of all COCs were below Method 1 S-1/GW-3 standards, with the exception of a slight exceedence of the 2 mg/kg standard for cadmium involving a maximum value of 5.5 mg/kg. Cadmium has a high frequency of detection in soil samples across the FMA, along with other metals. They are all at concentrations below S-1 standards for surficial soils and have not been attributed to the former production process involving phenolic compounds or urea formaldehyde resins. Being ubiquitous and consistently present across the FMA and not likely related to past process but rather more likely building products (e.g. paints) near point of application, they represent background conditions.

In accordance with 310 CMR 40.0860, the incremental cost of conducting additional remedial action to further remediate soil is expected to be disproportionate to the incremental benefit of risk reduction or environmental restoration. In addition, if the goal were to reduce metals in accessible soils below Method 1 S-1 standards, the area and extent of excavation would likely involve the whole 10.6 +/- acres of the FMA, having potential adverse affects on the wetland and wildlife habitat along the Shawsheen River. The costs to remove the soils and backfill over such a large area, if appropriate from an environmental protection standpoint, are expected to be greater than 20% of the remediation costs expended to date for the FMA to achieve NSR. Therefore, additional soil removal is deemed infeasible.

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Exhibits

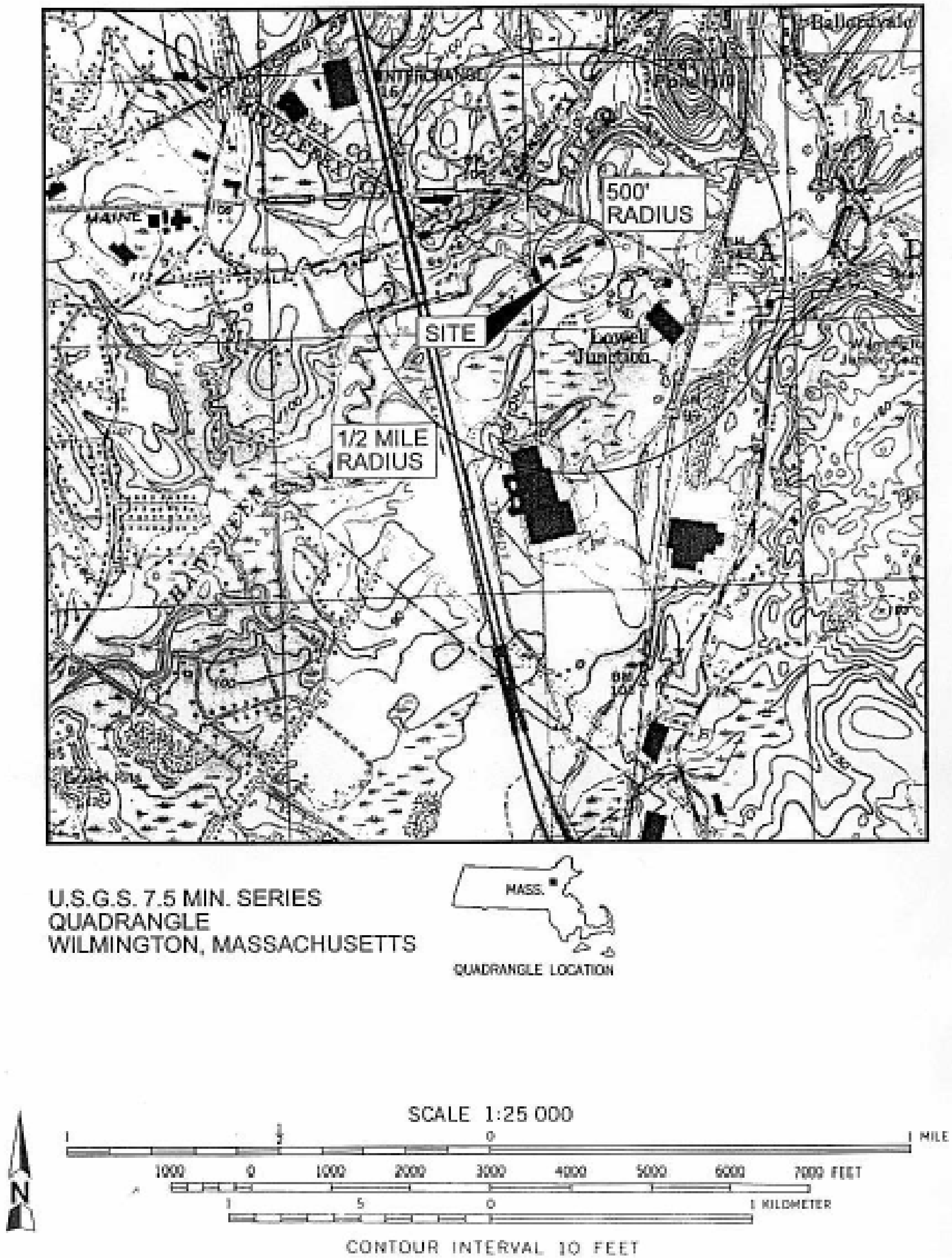


Exhibit 1-1
Site Locus Map
Reichhold, Incorporated
CH2MHILL

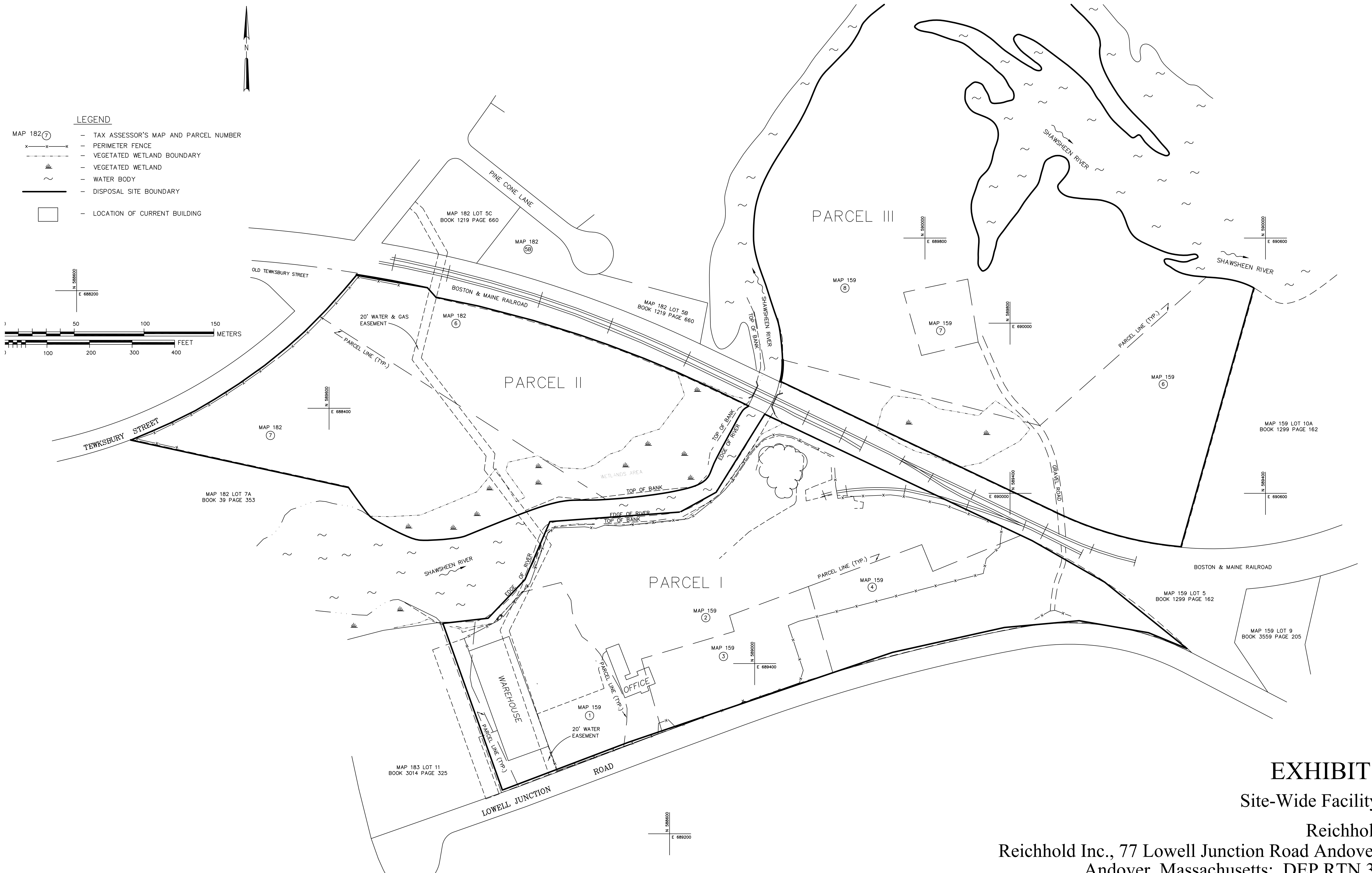


EXHIBIT 1-2

Site-Wide Facility Map

Reichhold Inc.

Reichhold Inc., 77 Lowell Junction Road Andover, MA
Andover, Massachusetts; DEP RTN 3-0208

CH2MHILL

11/21/12 Exhibit 1–2.dwg

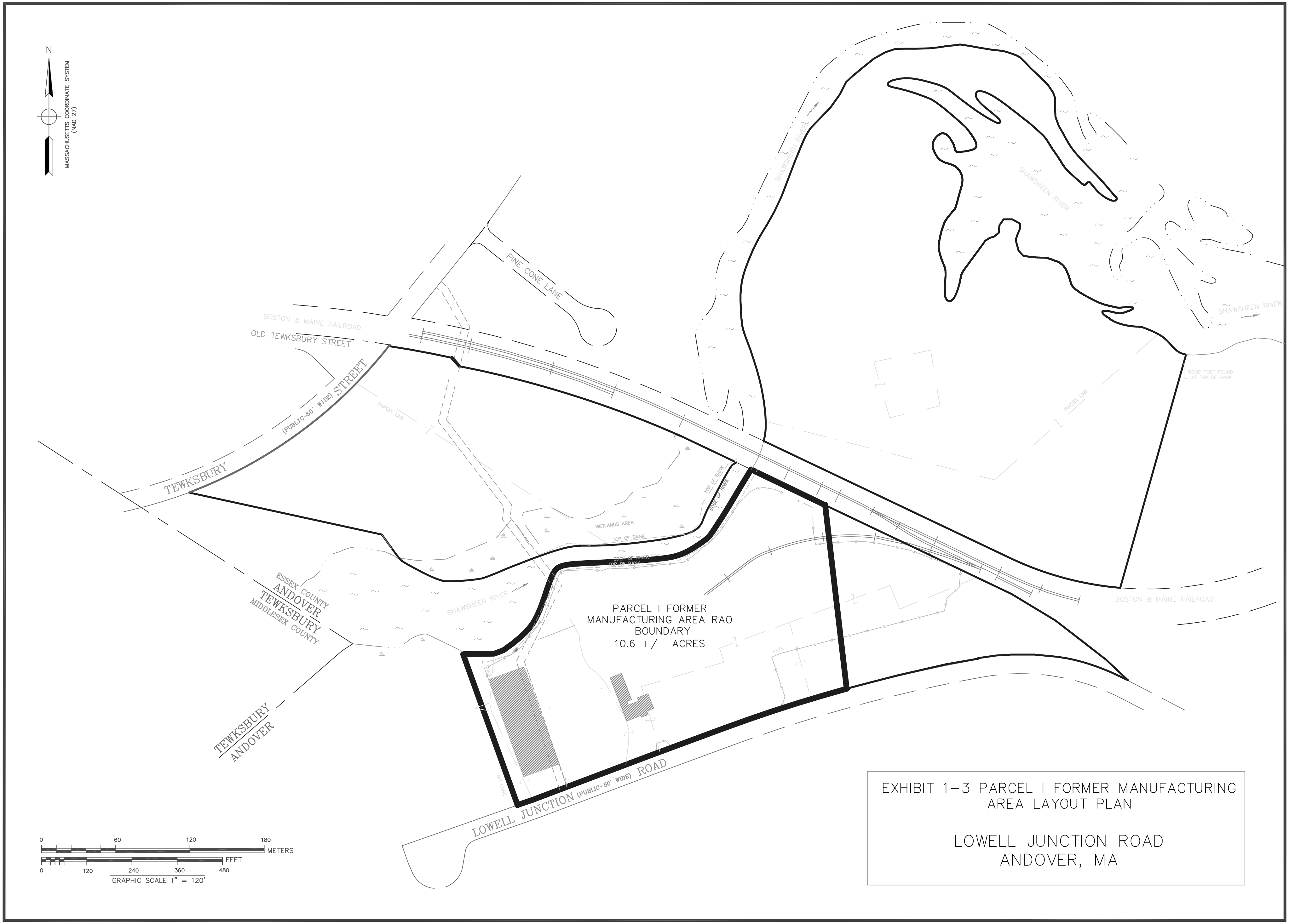


EXHIBIT 1–3 PARCEL I FORMER MANUFACTURING AREA LAYOUT PLAN

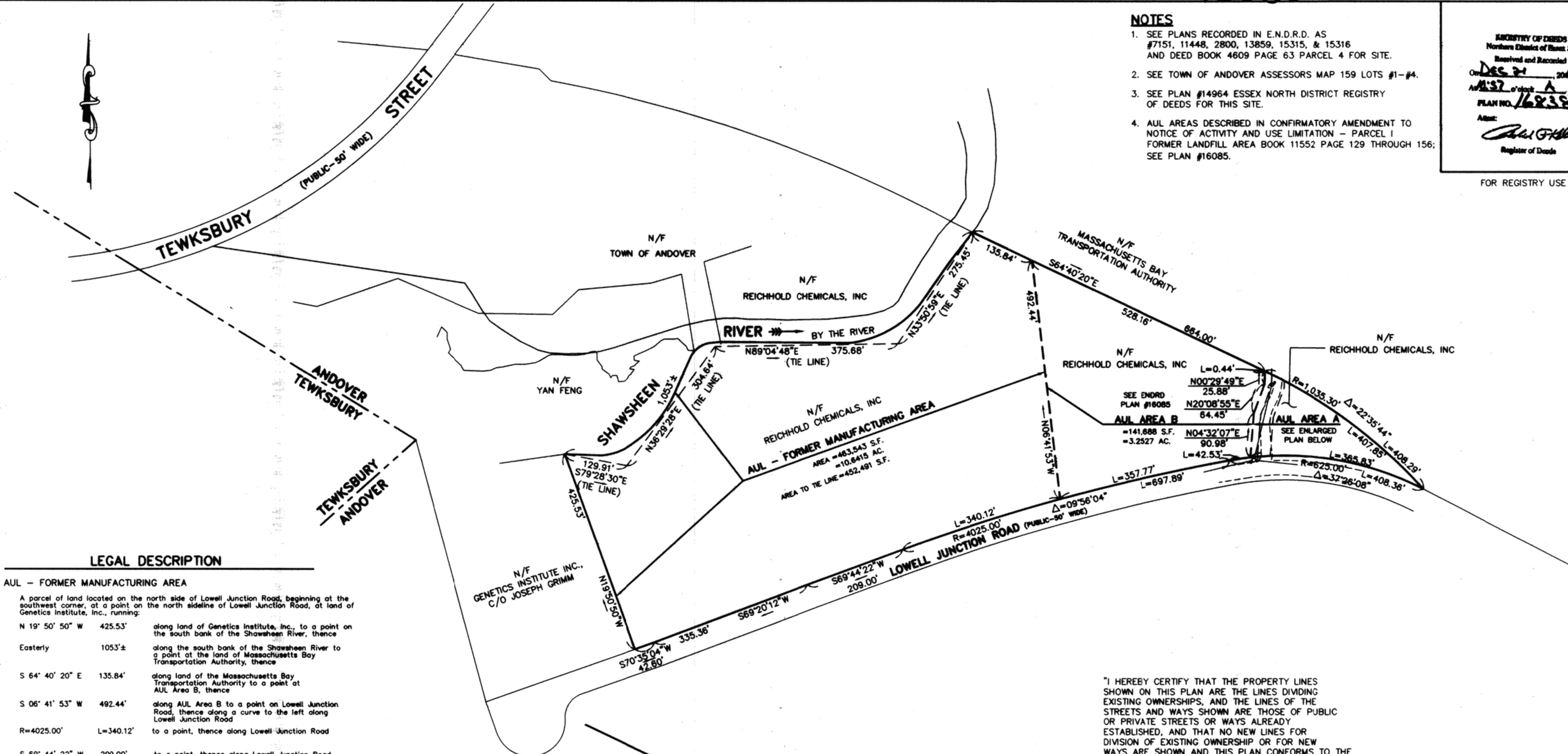
LOWELL JUNCTION ROAD
ANDOVER, MA

NOTES

1. SEE PLANS RECORDED IN E.N.D.R.D. AS #7151, 11448, 2800, 13859, 15315, & 15316 AND DEED BOOK 4609 PAGE 63 PARCEL 4 FOR SITE.
2. SEE TOWN OF ANDOVER ASSESSORS MAP 159 LOTS #1–#4.
3. SEE PLAN #14964 ESSEX NORTH DISTRICT REGISTRY OF DEEDS FOR THIS SITE.
4. AUL AREAS DESCRIBED IN CONFIRMATORY AMENDMENT TO NOTICE OF ACTIVITY AND USE LIMITATION – PARCEL I FORMER LANDFILL AREA BOOK 11552 PAGE 129 THROUGH 156; SEE PLAN #16085.

REGISTRY OF DEEDS
Northern District of Essex SS
Received and Recorded
On Dec 21, 2012
At 11:57 o'clock A m.
PLAN NO. 16838
Attest:
Register of Deeds

FOR REGISTRY USE



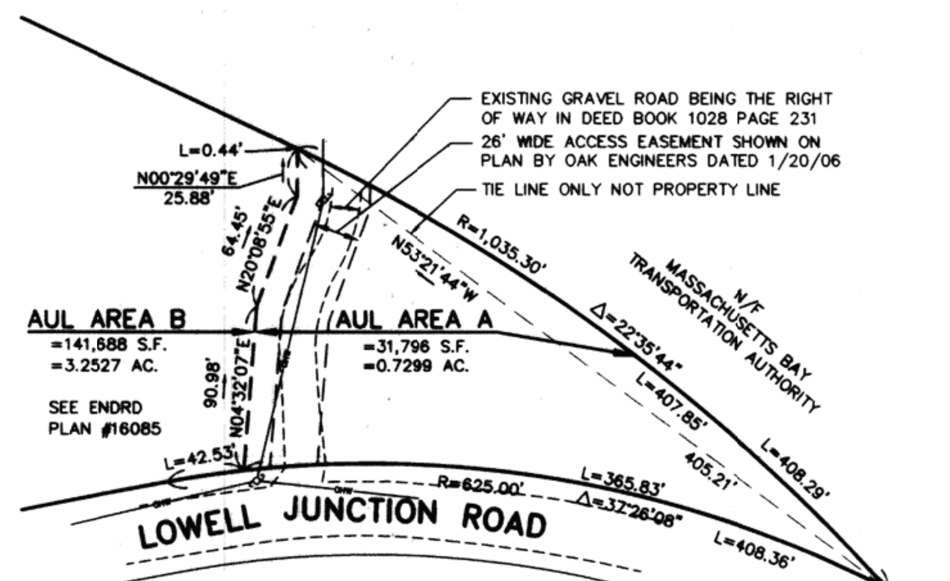
LEGAL DESCRIPTION

AUL – FORMER MANUFACTURING AREA

A parcel of land located on the north side of Lowell Junction Road, beginning at the southwest corner, at a point on the north sideline of Lowell Junction Road, at land of Genetics Institute, Inc., running:

N 19° 50' 50" W	425.53'	along land of Genetics Institute, Inc., to a point on the south bank of the Shawsheen River, thence
Easterly	1053'±	along the south bank of the Shawsheen River to a point at the land of Massachusetts Bay Transportation Authority, thence
S 64° 40' 20" E	135.84'	along land of the Massachusetts Bay Transportation Authority to a point at AUL Area B, thence
S 06° 41' 53" W	492.44'	along AUL Area B to a point on Lowell Junction Road, thence along a curve to the left along Lowell Junction Road
R=4025.00'	L=340.12'	to a point, thence along Lowell Junction Road
S 69° 44' 22" W	209.00'	to a point, thence along Lowell Junction Road
S 69° 20' 12" W	335.36'	to a point, thence along Lowell Junction Road
S 70° 35' 04" W	42.60'	to a point at land of Genetics Institute, Inc. said point being the point of beginning.

Said parcel contains 463,543 square feet or 10.6415 acres of land area and is shown as AUL–FORMER MANUFACTURING AREA on PLAN OF AUL–FORMER MANUFACTURING AREA in Andover, Massachusetts prepared for Reichhold Chemicals, Inc. Date December 4, 2012 Scale 1"=100' by Merrimack Engineering Services, Inc., 66 Park Street, Andover, MA 01810.



ENLARGED PLAN
SCALE 1"=50'

"I HEREBY CERTIFY THAT THE PROPERTY LINES SHOWN ON THIS PLAN ARE THE LINES DIVIDING EXISTING OWNERSHIPS, AND THE LINES OF THE STREETS AND WAYS SHOWN ARE THOSE OF PUBLIC OR PRIVATE STREETS OR WAYS ALREADY ESTABLISHED, AND THAT NO NEW LINES FOR DIVISION OF EXISTING OWNERSHIP OR FOR NEW WAYS ARE SHOWN AND THIS PLAN CONFORMS TO THE RULES AND REGULATIONS OF THE REGISTRY OF DEEDS."

STEPHEN E. STAPINSKI R.L.S. — 12/17/12 DATE

Exhibit 1-4

PLAN OF AUL–FORMER MANUFACTURING AREA

IN

ANDOVER, MASSACHUSETTS

PREPARED FOR

REICHHOLD CHEMICALS, INC.

DATE DECEMBER 17, 2012

SCALE 1"=100'
1"=50'

0' 50' 100' 200' 300'
0' 25' 50' 100' 150'

MERRIMACK ENGINEERING SERVICES
66 PARK STREET
ANDOVER, MASSACHUSETTS 01810

COMMONWEALTH OF MASSACHUSETTS STEPHEN E. STAPINSKI #29875 PROFESSIONAL LAND SURVEYOR

16838

X:\R14 2008\DWGS\7319-01\AUL\731901AUL02.DWG 12/17/12

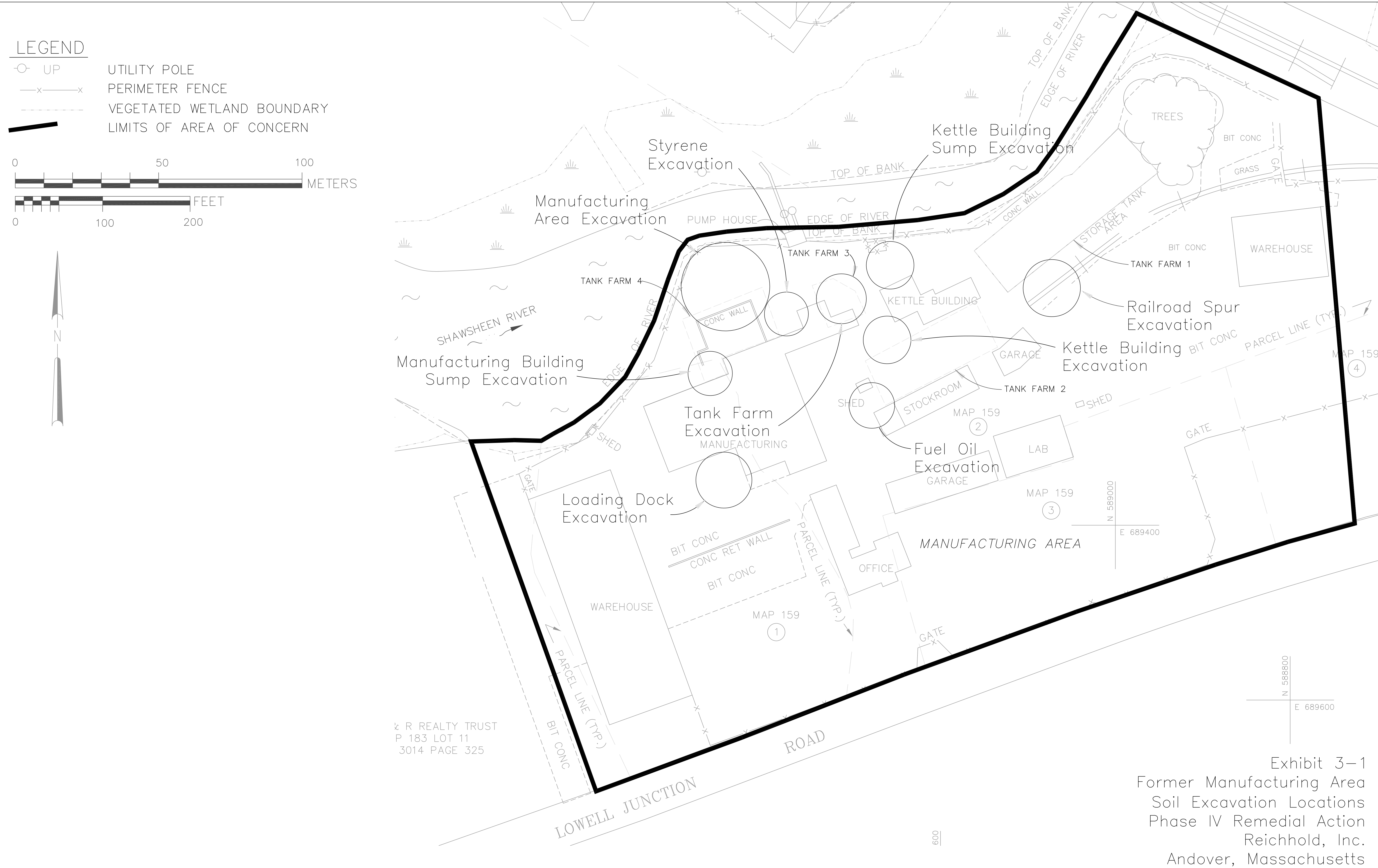


Exhibit 3-1
Former Manufacturing Area
Soil Excavation Locations
Phase IV Remedial Action
Reichhold, Inc.
Andover, Massachusetts

11/19/2012 Exhibit 3-1.dwg

CH2MHILL

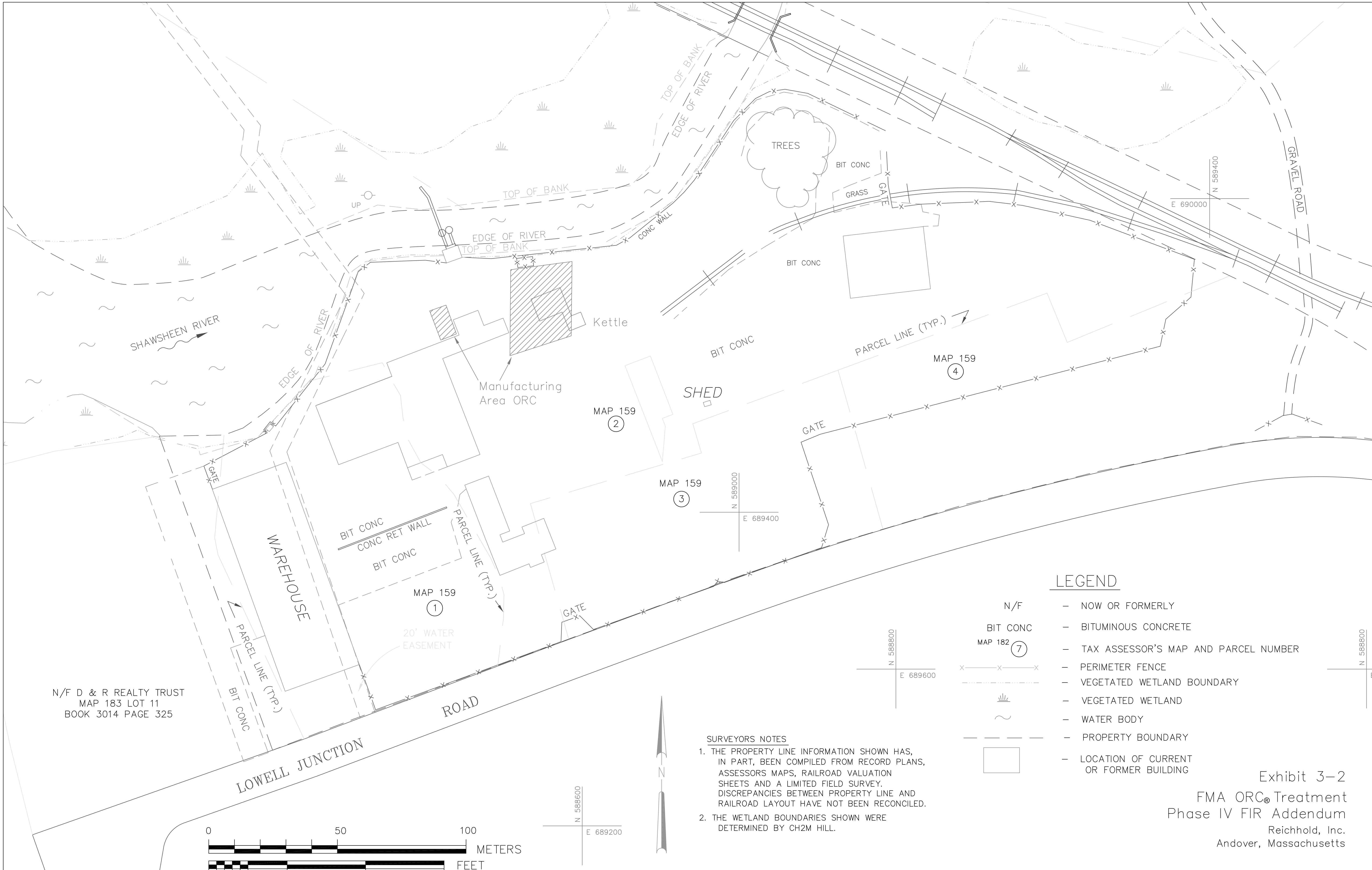


Exhibit 3–2
FMA ORC® Treatment
Phase IV FIR Addendum
Reichhold, Inc.
Andover, Massachusetts

CH2MHILL

11/19/12 Exhibit 3–2.dwg

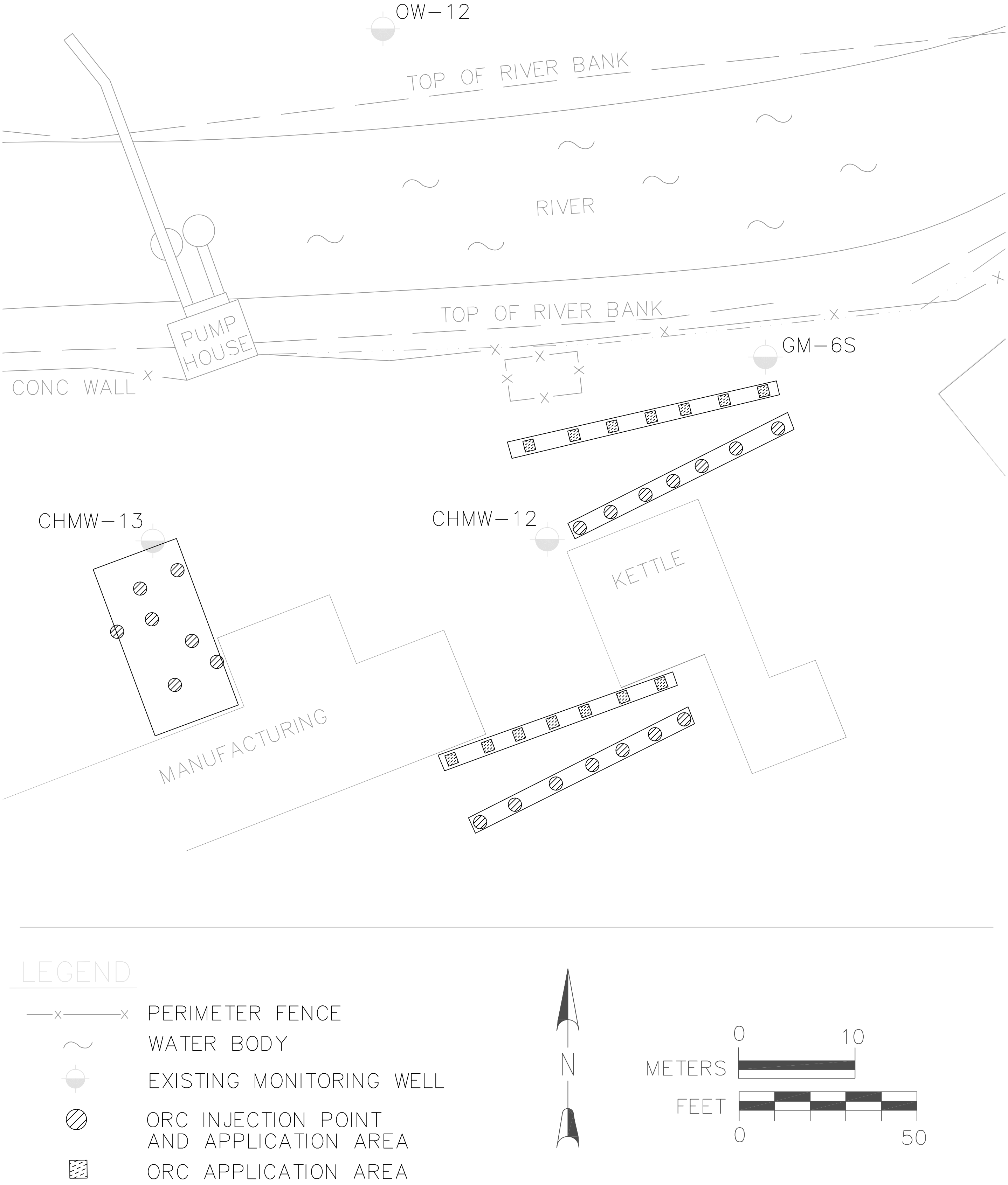
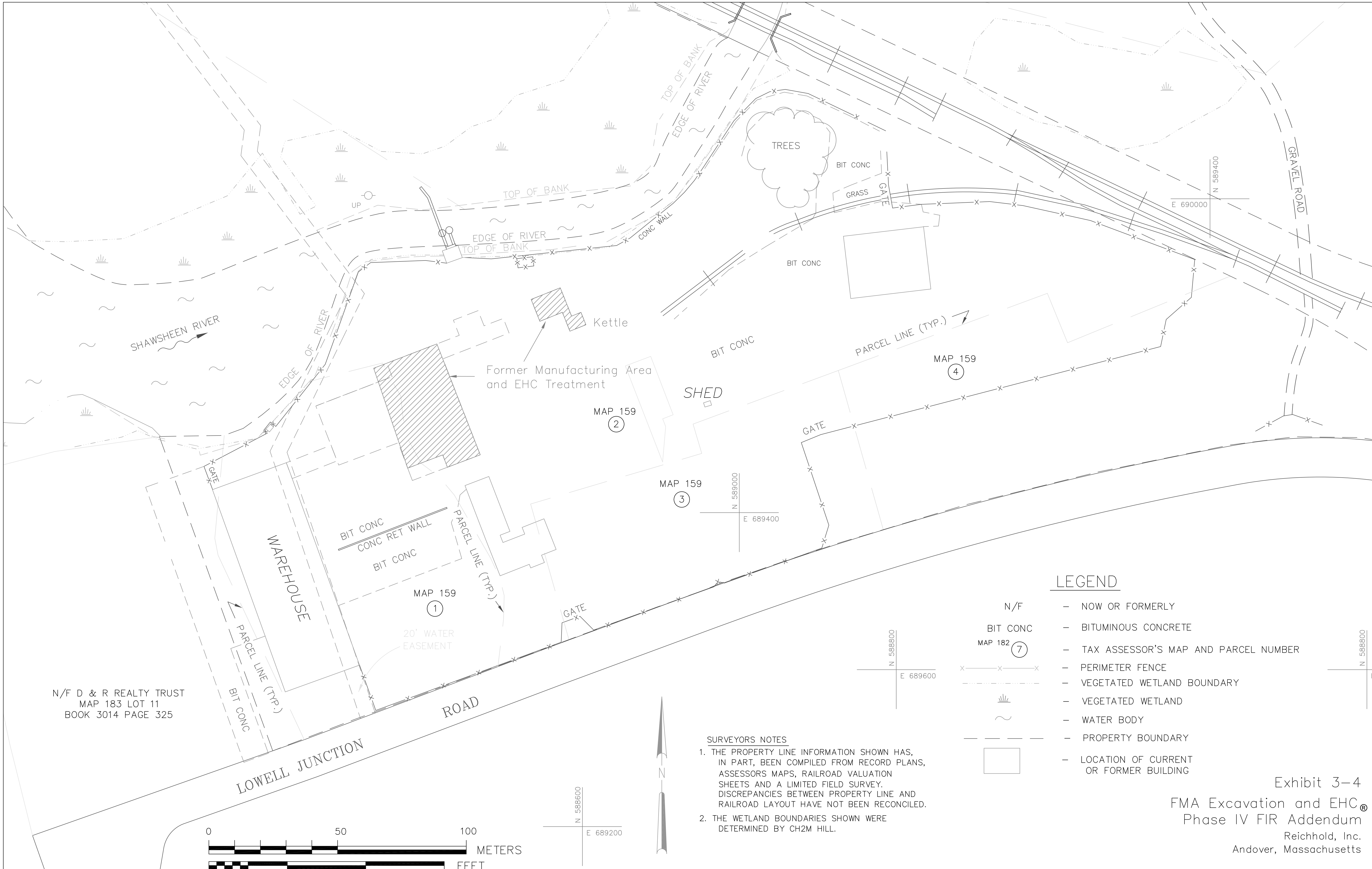


Exhibit 3-3
FMA ORC® Application Locations
Former Manufacturing Area

Reichhold, Inc.
Andover, MA

CH2MHILL



LEGEND

N/F – NOW OR FORMERLY
BIT CONC – BITUMINOUS CONCRETE
MAP 182 (7) – TAX ASSESSOR'S MAP AND PARCEL NUMBER
– PERIMETER FENCE
– VEGETATED WETLAND BOUNDARY
– VEGETATED WETLAND
– WATER BODY
– PROPERTY BOUNDARY
– LOCATION OF CURRENT OR FORMER BUILDING

SURVEYORS NOTES

1. THE PROPERTY LINE INFORMATION SHOWN HAS, IN PART, BEEN COMPILED FROM RECORD PLANS, ASSESSORS MAPS, RAILROAD VALUATION SHEETS AND A LIMITED FIELD SURVEY. DISCREPANCIES BETWEEN PROPERTY LINE AND RAILROAD LAYOUT HAVE NOT BEEN RECONCILED.
2. THE WETLAND BOUNDARIES SHOWN WERE DETERMINED BY CH2M HILL.

Exhibit 3–4
FMA Excavation and EHC®
Phase IV FIR Addendum
Reichhold, Inc.
Andover, Massachusetts

11/19/12 Exhibit 3–2.dwg

CH2MHILL

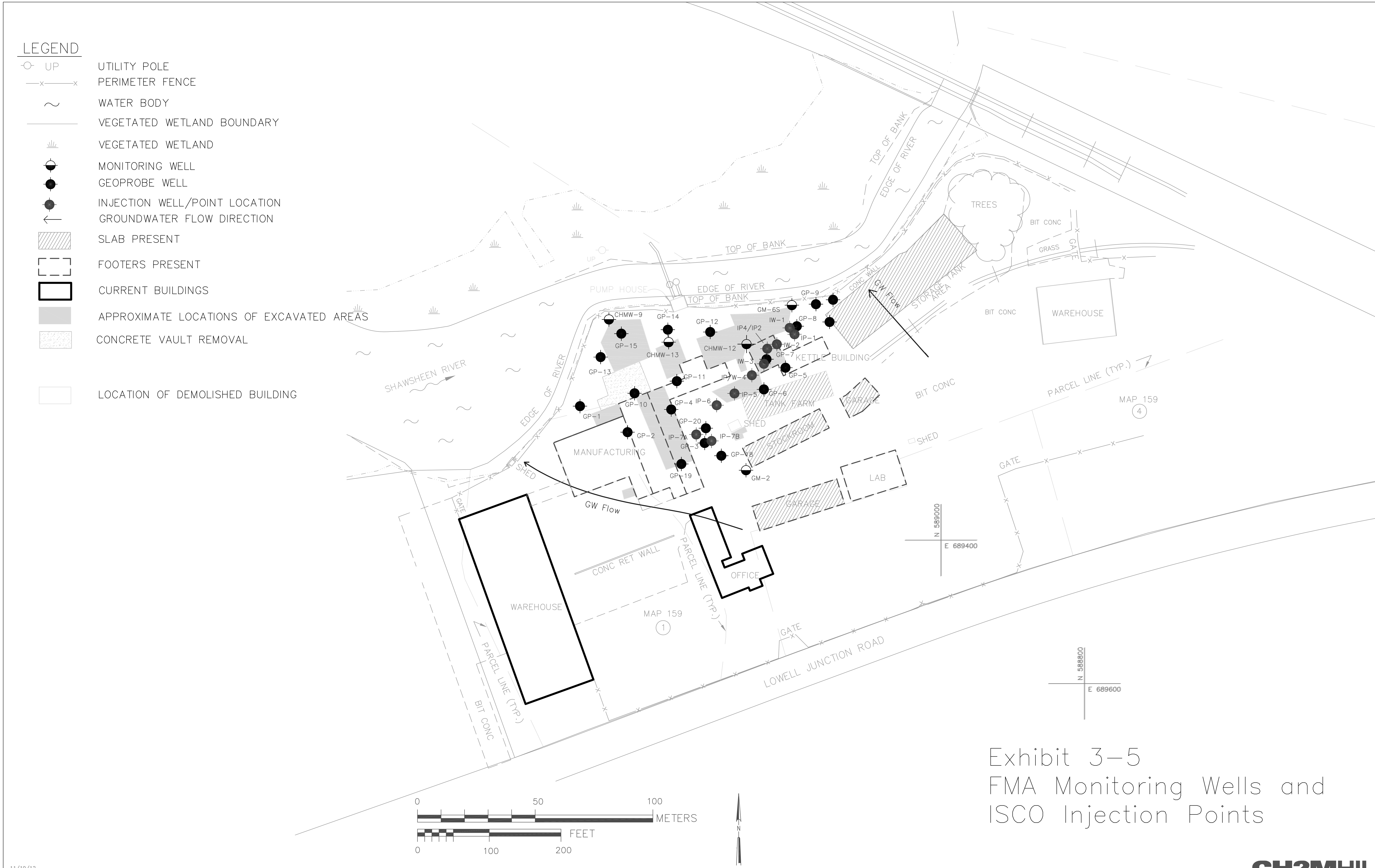


Exhibit 3–5
FMA Monitoring Wells and
ISCO Injection Points

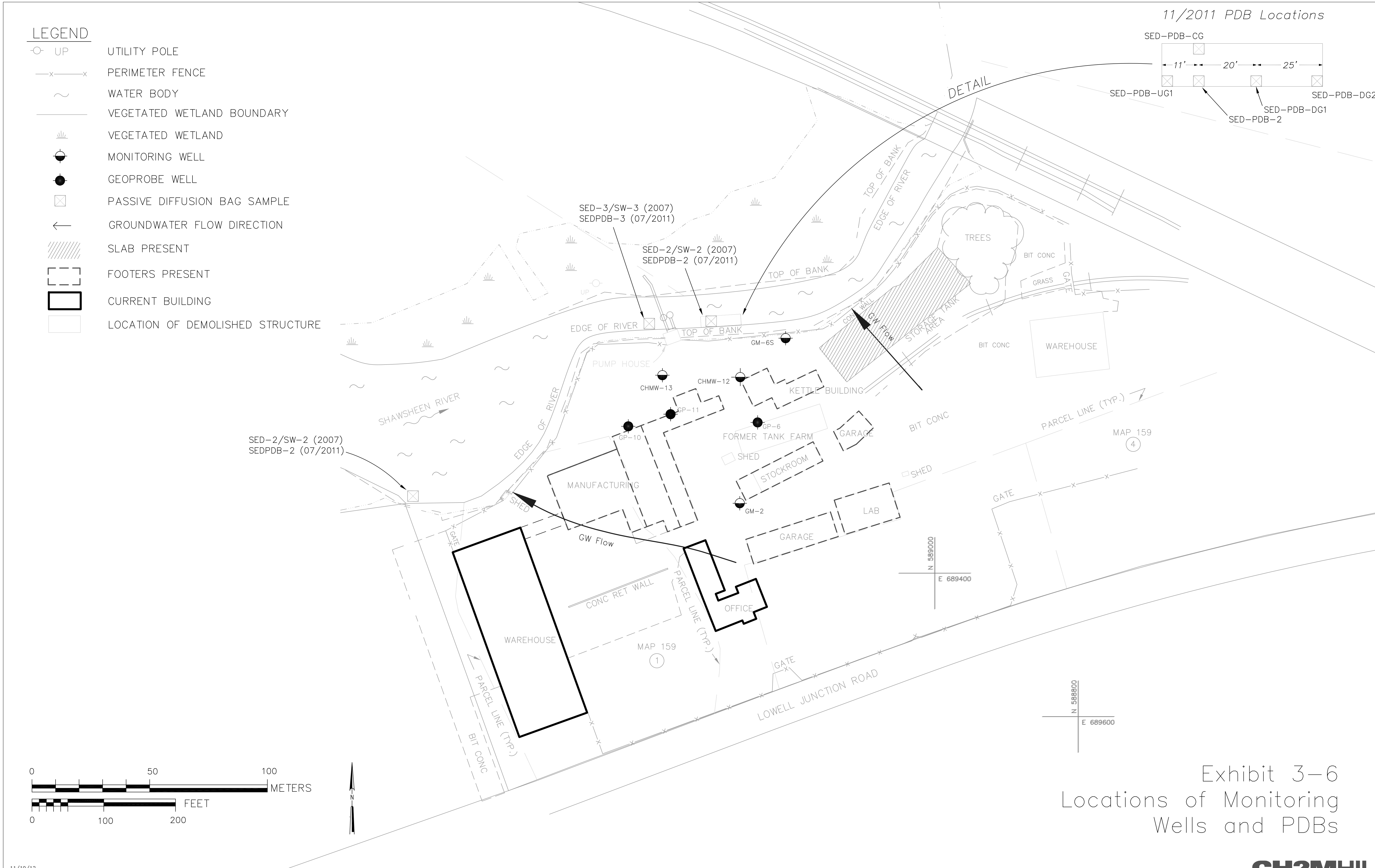


Exhibit 3-6
Locations of Monitoring Wells and PDBs

CH2MHILL

Tables

Table 3-1
Summary of Water Quality Parameters and Contaminants of Concern -- Pre- and Post-ISCO
Former Manufacturing Area
Reichhold, Inc., Andover, Massachusetts

Well ID	GW-2	GW-3	CHMW-9						CHMW-12										
Date	Criteria	Criteria	Jul-05	Dec-05	Jul-06	Dec-06	May-07	Oct-07	Jul-06	Dec-06	May-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line	(ug/L)	(ug/L)							~ 35-ft Northwest of Injection Line										
Water Quality Parameters																			
pH	NA	NA	6.78	6.75	4.94	6.50	5.27	6.98	4.47	4.67	4.41	6.96	6.46	6.48	6.92	6.71	6.44	6.76	6.3
Specific Conductivity (mS/cm)	NA	NA	0.864	0.338	0	0.381	0.409	0.711	7.07	4.68	0.655	0.54	0.497	0.409	0.697	0.475	0.671	0.555	0.79
Temperature (C)	NA	NA	12.37	11.50	13.99	12.81	11.63	16.65	14.71	13.65	10.04	11.67	16.38	12.28	14.28	16.2	14.73	13.31	15.55
Redox (mV)	NA	NA	-151.0	-79.0	374.3	-114.0	228.1	-121.5	70.1	136	443	-72	-119.8	-162.4	-84.5	-65.1	-57.3	-121.9	-52.4
Dissolved Oxygen (mg/L)	NA	NA	0.05	0.14	3.16	0.00	0.25	0.74	2.71	NA	0.16	1.08	0.17	1.01	0.18	0.60	0.39	0.31	0.23
Volatile Organic Compounds (ug/L)																			
Benzene	2000	10000	ND	ND	1.4	ND	1.4	1	ND	ND	0.6J	ND	ND	ND	ND	ND	ND	0.5	ND
n-Butylbenzene	NA	NA	18	NA	18	ND	19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	200	1000	27	ND	11	21	12	20	ND	ND	1.8	ND	ND	ND	1.8	ND	ND	2.3	1.5
Chloromethane	NA	NA	ND	ND	ND	ND	ND	ND	1300	486	18	ND	ND	ND	ND	ND	1.1	ND	ND
Ethylbenzene	20000	5000	310	ND	ND	ND	0.7	ND	1900	897	2060	1460	1930	863	231	84	37	176	67
Isopropylbenzene	NA	NA	45	31	34	39	36	38	ND	13	24	21	23	24	8.9	26	19	25	15
n-Propylbenzene	NA	NA	52	32	34	39	34	19	ND	11	20	17	22	23	5.4	15	12	18	11
1,2,4-Trimethylbenzene	NA	NA	1700	1500	620	476	101	96	960	273	440	214	406	283	89	450	177	337	254
1,3,5-Trimethylbenzene	NA	NA	ND	ND	ND	ND	ND	ND	ND	108	157	43	89	96	41	66	26	46	45
Total Xylenes (mixed isomers)	9000	5000	ND	ND	ND	ND	0.6	1	**8700**	2954	**6957**	2673	3480	2181	1146	862	199	1194	902
Geochemical Parameter for Distribution (mg/L)																			
Sulfate, using EPA 300.0			ND	ND	ND	ND	NA	NA	6600	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	CHMW-13												
Date	Jul-05	Dec-05	Jul-06	Dec-06	May-07	Oct-07	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line													
Water Quality Parameters													
pH	7.32	7.51	7.05	7.14	5.56	7.19	7.09	7.05	7.03	6.94	6.62	6.87	6.4
Specific Conductivity (mS/cm)	0.524	0.377	0.378	0.253	0.168	0.653	0.405	0.297	0.429	0.740	0.626	0.376	0.602
Temperature (C)	16.79	8.10	19.49	11.03	10.28	18.90	19.44	14.75	14.18	15.82	12.39	14.95	16.08
Redox (mV)	-226.0	-169	-112	-200	228	-123.2	-102.1	-168.5	-112.0	-100.1	-83.8	-131.6	-65.8
Dissolved Oxygen (mg/L)	0.04	0.16	0.90	0.00	0.17	0.94	-0.10	0.79	0.08	0.70	0.26	0.56	0.06
Volatile Organic Compounds (ug/L)													
Benzene	ND	ND	ND	ND	ND	8	ND	0.5 UJ	ND	26	ND	ND	ND
n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8	ND	ND	ND
Chlorobenzene	ND	ND	ND (<250)	ND	72	ND	86	50	109	417	ND	38	32
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	33	ND	ND
Ethylbenzene	**22000**	**32000**	**44000**	**19100**	**21900**	**25700**	**15700**	**7470**	**15600**	1070	1460	1950	2060
Isopropylbenzene	ND	ND	ND	ND	27	37	22	15	29	26	10	11	16
n-Propylbenzene	ND	ND	ND	ND	10	16	9.4	5.4	11	16	3.5J	3.4	5.1
1,2,4-Trimethylbenzene	ND	ND	ND	ND	82	ND	96	53	123 J	238	32	17	45
1,3,5-Trimethylbenzene	ND	ND	ND	ND	5.4	15	8.6	3.2	5.3	ND	ND	ND	5.9
Total Xylenes (mixed isomers)	ND	ND	ND (<1000)	ND	144	122	77.2	30.3	106	ND	ND	10	3.5
Geochemical Parameter for Distribution (mg/L)													
Sulfate, using EPA 300.0	ND	22	36	5.7	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GM-2													
Date	Jul-05	Dec-05	Jul-06	Dec-06	May-07	Oct-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line	~63-ft Southeast of Injection Line													
Water Quality Parameters														
pH	7.14	6.93	6.47	6.74	6.33	6.94	7.23	7.05	7.00	6.91	6.93	6.5	6.84	6.45
Specific Conductivity (mS/cm)	0.695	0.380	0.315	0.389	0.291	0.603	0.444	0.407	0.376	0.345	0.467	0.567	0.456	0.549
Temperature (C)	16.60	11.50	17.47	13.79	10.52	19.73	13.59	19.82	14.56	16.38	20.29	14.78	15.15	18.54
Redox (mV)	-217	-82	-78.6	-132.0	-68.5	-140.6	-90.0	-102.2	-137.2	-93.0	-87.0	-31.7	-75.2	-69.7
Dissolved Oxygen (mg/L)	0.11	0.26	1.30	NA	1.68	1.02	1.05	0.34	0.42	0.07	0.75	0.18	0.24	0.19
Volatile Organic Compounds (ug/L)														
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5
n-Butylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	6	4.2	4.9	3.6	2.8	3	4	3.8	3.8	4.4	4.2	1.9	3.3	3.9
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	8.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isopropylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Propylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Xylenes (mixed isomers)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5	ND
Geochemical Parameter for Distribution (mg/L)														
Sulfate, using EPA 300.0	17	11	12	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GW-2	GW-3	GM-6S													
Date	Criteria	Criteria	Dec-05	Jul-06	Oct-06	Dec-06	May-07	Oct-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jul-11	Oct-11
Relative Location to Persulfate Injection Line	(ug/L)	(ug/L)	~ 30-ft North of Injection Line													
Water Quality Parameters																
pH	NA	NA	6.55	6.32	5.31	6.77	5.12	6.58	6.95	6.71	6.72	6.49	6.57	6.33	6.39	6.11
Specific Conductivity (mS/cm)	NA	NA	0.341	2.33	0.001	1.35	0.455	1.011	0.543	0.662	0.495	0.643	0.577	0.734	0.385	0.656
Temperature (C)	NA	NA	9.9	15.92	23.51	11.10	10.38	16.80	11.83	17.12	12.83	14.95	15.84	14.17	12.62	16.61
Redox (mV)	NA	NA	-49	-15.60	-98	-133	-69	-94.2	-63.4	-81.3	-174.6	-48.2	-41.2	-31.7	-68.6	-39.1
Dissolved Oxygen (mg/L)	NA	NA	0.19	2.83	7.80	NA	0.44	1.20	1.02	1.44	2.07	2.12	1.37	1.4	2.27	0.38
Volatile Organic Compounds (ug/L)																
Benzene	2000	10000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene	NA	NA	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	200	1000	ND	ND	ND	7.5	8.4	28	10	19	10	18	11	12	5.8	5.9
Chloromethane	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	20000	5000	840	500	800	541	756	378	233	109	32	34	ND	19	6.1	7.8
Isopropylbenzene	NA	NA	ND	ND	ND	39	53	64	46	56	43	53	45	51	31	28
n-Propylbenzene	NA	NA	ND	ND	ND	ND	5.8	8	6	7.3	5.1	6.6	4.9	5.3	4.2	3.1
1,2,4-Trimethylbenzene	NA	NA	ND	ND	ND	65	78	94J	75	137	77	97	77	74	72	51
1,3,5-Trimethylbenzene	NA	NA	ND	ND	ND	36	44	70	40	63	39	47	32	20	20	12
Total Xylenes (mixed isomers)	9000	5000	**14400**	**6890**	**8060**	3726	3988	4126	4100	3699	1895	1537	264	71.1	266.4	221
Geochemical Parameter for Distribution (mg/L)																
Sulfate, using EPA 300.0			ND	1,300	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GP-03					GP-05			
Date	Mar-06	Oct-06	Dec-06	May-07	Oct-07	Mar-06	Oct-06	Dec-06	May-07
Relative Location to Persulfate Injection Line	~ 4-ft SE of Injection Line					~ 28-ft Southeast of Injection Line			
Water Quality Parameters									
pH	NA	5.92	6.65	6.73	NA	NA	6.17	7.05	7.14
Specific Conductivity (mS/cm)	NA	0.605	0.456	0.501	NA	NA	0.661	0.354	0.267
Temperature (C)	NA	16.95	13.59	10.55	NA	NA	18.25	8.79	9.9
Redox (mV)	NA	77	-97	-100.3	NA	NA	72	-306	-188
Dissolved Oxygen (mg/L)	NA	0.24	0	2.23	NA	NA	0.38	0.00	1.89
Volatile Organic Compounds (ug/L)									
Benzene	ND	ND	ND	4	NA	ND	ND	ND	0.5
n-Butylbenzene	600	ND	ND	ND	NA	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	2.4	NA	ND	ND	ND	0.6
Chloromethane	ND	ND	ND	ND	NA	ND (<500)	ND	ND	ND
Ethylbenzene	1900	210	369	352	NA	**11000**	610	1090	736
Isopropylbenzene	ND	ND	35	38	NA	ND	ND	ND	3.6
n-Propylbenzene	430	44	58	62	NA	ND	ND	ND	1.7
1,2,4-Trimethylbenzene	17000	1400	1680	1760	NA	ND	3900	62	42
1,3,5-Trimethylbenzene	5400	380	490	515	NA	ND	1300	16	12
Total Xylenes (mixed isomers)	**29900**	2824	3218	3944	NA	**68000**	**8200**	3760	2910
Geochemical Parameter for Distribution (mg/L)									
Sulfate, using EPA 300.0	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GP-06												
Date	Mar-06	Jul-06	Oct-06	Dec-06	May-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line	~ 26-ft East of Injection Line												
Water Quality Parameters													
pH	NA	5.99	6.03	6.91	6.79	7.18	6.68	6.94	6.66	6.8	6.51	6.78	6.29
Specific Conductivity (mS/cm)	NA	0.784	2.2	0.401	0.283	0.559	0.577	0.504	0.586	0.514	0.628	0.525	0.856
Temperature (C)	NA	16.17	18.16	10.87	9.41	12.55	16.81	13.73	14.53	17.07	12.41	13.79	15.55
Redox (mV)	NA	-21.6	77	-134	-143	-90.2	-111.3	-143.5	-73.1	-69.2	-70.5	-92.5	-43
Dissolved Oxygen (mg/L)	NA	1.2	4.59	NA	1.86	1.02	1.37	1.13	1.08	0.71	1.31	1.17	0.98
Volatile Organic Compounds (ug/L)													
Benzene	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene	290	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND	ND	ND
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	1400	730	1100	947	666	356	446	436	355	239	124	206	350
Isopropylbenzene	ND	120	ND	79	75	63	68	71	64	56	38	46	55
n-Propylbenzene	ND	140	ND	111	103	68	86	109	92	90	51	55	82
1,2,4-Trimethylbenzene	6200	4900	1700	4780	4270	2860	3330	5090	4080	3600	1660	2670	3240
1,3,5-Trimethylbenzene	2300	1600	ND	1780	1550	1010	1100	1800	1320	1300	600	999	1040
Total Xylenes (mixed isomers)	**15300**	**11500**	**19490**	**11960**	**8460**	4100	4605	**5519**	3619	2353	728	2043	2274
Geochemical Parameter for Distribution (mg/L)													
Sulfate, using EPA 300.0	NA	260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GP-07				
Date	Mar-06	Jul-06	Oct-06	Dec-06	May-07
Relative Location to Persulfate Injection Line	On Injection Line				
Water Quality Parameters					
pH	NA	6.7	6.7	6.88	7.13
Specific Conductivity (mS/cm)	NA	1.343	0.712	0.388	0.275
Temperature (C)	NA	18.14	19.04	11.20	9.76
Redox (mV)	NA	117.8	64	-314	-205
Dissolved Oxygen (mg/L)	NA	0.27	2.23	NA	1.47
Volatile Organic Compounds (ug/L)					
Benzene	ND	ND	ND	ND	ND
n-Butylbenzene	ND	ND	ND	ND	11
Chlorobenzene	ND	ND	ND	ND	ND
Chloromethane	ND (<250)	ND	ND	ND	ND
Ethylbenzene	4100	580	49	67	247
Isopropylbenzene	ND	ND	4.9	8.1	10
n-Propylbenzene	ND	ND	4.4	5.6	7.2
1,2,4-Trimethylbenzene	ND	ND	61	58	83
1,3,5-Trimethylbenzene	ND	ND	ND	ND	8.5
Total Xylenes (mixed isomers)	**21300**	**1773**	155	202	654
Geochemical Parameter for Distribution (mg/L)					
Sulfate, using EPA 300.0	NA	340	NA	NA	NA

Well ID	GW-2	GW-3	GP-08				GP-09			
Date	Criteria	Criteria	Mar-06	Oct-06	Dec-06	May-07	Mar-06	Jul-06	Dec-06	May-07
Relative Location to Persulfate Injection Line	(ug/L)	(ug/L)	Injection Point				~ 41-ft Northeast of Injection Line			
Water Quality Parameters										
pH	NA	NA	NA	6.12	6.26	6.35	NA	6.88	6.75	7.18
Specific Conductivity (mS/cm)	NA	NA	NA	0.457	0.443	0.335	NA	0.316	0.235	0.287
Temperature (C)	NA	NA	NA	18.14	11.91	8.54	NA	20.34	10.47	10.83
Redox (mV)	NA	NA	NA	64	-139	-37.2	NA	-94.50	-100	-96
Dissolved Oxygen (mg/L)	NA	NA	NA	NA	NA	0.65	NA	0.14	NA	0.46
Volatile Organic Compounds (ug/L)										
Benzene	2000	10000	ND	ND	ND	ND	ND	ND	ND	ND
n-Butylbenzene	NA	NA	290	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	200	1000	ND	ND	7.8	4.3	ND	ND	ND	ND
Chloromethane	NA	NA	ND (<500)	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	20000	5000	**14000**	1800	332	590	17	ND	ND	ND
Isopropylbenzene	NA	NA	ND	ND	ND	4.4	ND	ND	ND	ND
n-Propylbenzene	NA	NA	ND	ND	ND	0.7	ND	ND	ND	ND
1,2,4-Trimethylbenzene	NA	NA	910	ND	5.1	6.9	ND	ND	ND	ND
1,3,5-Trimethylbenzene	NA	NA	ND	ND	ND	2.9	ND	ND	ND	ND
Total Xylenes (mixed isomers)	9000	5000	**99000**	**5700**	2147	3966	467	9.5	1.4	0.9
Geochemical Parameter for Distribution (mg/L)										
Sulfate, using EPA 300.0			NA	NA	NA	NA	NA	13	NA	NA

Well ID	GP-10											
Date	Mar-06	Dec-06	May-07	Oct-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line												
Water Quality Parameters												
pH	NA	6.65	NA	NA	6.75	7.09	6.47	6.36	6.59	6.31	6.45	6.22
Specific Conductivity (mS/cm)	NA	0.582	NA	NA	0.582	0.528	0.443	0.588	0.392	1.301	0.505	1.084
Temperature (C)	NA	12.32	NA	NA	11.69	16.83	12.72	14.63	16.19	13.25	13.04	16.01
Redox (mV)	NA	-89	NA	NA	-26.7	-84	-158.8	-44.1	-52.9	5.5	-88.1	-23.6
Dissolved Oxygen (mg/L)	NA	0.00	NA	NA	1.58	1.54	0.84	1.99	2.05(6)	1.37(6)	0.53	0.54
Volatile Organic Compounds (ug/L)												
Benzene	ND	ND	NA	NA	ND	ND	1.4	1	ND	0.9J	1.5	ND
n-Butylbenzene	160	ND	NA	NA	ND	ND	ND	ND	58	15	32	ND
Chlorobenzene	65	ND	NA	NA	71	56	75	62	101	ND	80	4.5
Chloromethane	ND	ND	NA	NA	ND	ND	ND	ND	ND	45	ND	ND
Ethylbenzene	340	95	NA	NA	34	47	16	4.1	17	14	10	3
Isopropylbenzene	74	34	NA	NA	75	69	80	59	95	45	74	5.1
n-Propylbenzene	70	19	NA	NA	52	49	47	39	72	32	52	2.9
1,2,4-Trimethylbenzene	2500	347	NA	NA	473	630	593	572	1750	112	852	27
1,3,5-Trimethylbenzene	760	109	NA	NA	19	46	8.3	10	51	8.5	53	1.4
Total Xylenes (mixed isomers)	1854	342	NA	NA	89	147	92	105	370	114	188	6.4
Geochemical Parameter for Distribution (mg/L)												
Sulfate, using EPA 300.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GP-11											
Date	Mar-06	Dec-06	May-07	Oct-07	Jun-08	Sep-08	Jun-09	Oct-09	Aug-10	Dec-10	Jun-11	Oct-11
Relative Location to Persulfate Injection Line												
Water Quality Parameters												
pH	NA	6.93	7.86	NA	8.36	7.59	8.45	6.94	8.05	7.06	7.18	6.3
Specific Conductivity (mS/cm)	NA	0.454	0.334	NA	0.654	0.72	0.653	0.559	0.801	0.925	0.583	0.682
Temperature (C)	NA	12.15	9.67	NA	11.80	17.48	12.61	14.59	16.03	13.31	14.2	16.54
Redox (mV)	NA	-153	-165.0	NA	-194.4	-142.2	-253.7	-92.3	-189.6	-99.7	-107.9	-32.7
Dissolved Oxygen (mg/L)	NA	0.00	1.80	NA	0.65	0.5	0.67	0.85	0.70	0.21	0.88	0.42
Volatile Organic Compounds (ug/L)												
Benzene	ND	ND	5.3	NA	26	9	38	5.4	109	15	26	ND
n-Butylbenzene	ND	ND	ND	NA	ND	ND	14	ND	51	2.4	6.7	ND
Chlorobenzene	54	ND	44	NA	206	128	345	34	**1580**	ND	148	19
Chloromethane	ND	ND(<500)	ND	NA	ND	ND	ND	ND	ND	59	ND	ND
Ethylbenzene	3400	**14100**	**10200**	NA	3540	3300	1480	2010	14	288	491	889
Isopropylbenzene	ND	ND	9.5	NA	16	12	30	9	73	11	19	4.4
n-Propylbenzene	ND	ND	3.8	NA	14	7.8	29	ND	99	6.7	16	1.2
1,2,4-Trimethylbenzene	ND	ND	41	NA	159	118	507	39	1130	100	172	11
1,3,5-Trimethylbenzene	ND	ND	3.9	NA	8	ND	2.2	ND	ND	ND	1.7	2.3
Total Xylenes (mixed isomers)	170	ND	153	NA	110	83.5	103.7	38	41	0.6	36.9	1.1
Geochemical Parameter for Distribution (mg/L)												
Sulfate, using EPA 300.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well ID	GP-16				GP-17			
Date	Jul-06	Oct-06	Dec-06	May-07	Jul-06	Oct-06	Dec-06	May-07
Relative Location to Persulfate Injection Line	~ 46-ft Northeast of Injection line				~ 62-ft Northeast of Injection line			
Water Quality Parameters								
pH	6.02	6.06	6.16	8.55	6.69	6.63	6.57	6.97
Specific Conductivity (mS/cm)	0.175	0.191	0.128	0.167	0.349	0.052	0.397	0.297
Temperature (C)	19.02	19.4	10.70	10.03	18.68	19.23	11.76	11.81
Redox (mV)	-15	77	-39	-52.4	-34.7	130	-48	-82
Dissolved Oxygen (mg/L)	1.9	0.14	NA	0.47	4.23	NA	NA	6.4
Volatile Organic Compounds (ug/L)								
Benzene	ND	NA	ND	ND	ND	NA	ND	ND
n-Butylbenzene	ND	NA	ND	ND	ND	NA	ND	ND
Chlorobenzene	ND	NA	ND	ND	ND	NA	0.6J	ND
Chloromethane	ND	NA	ND	ND	ND	NA	ND	ND
Ethylbenzene	ND	NA	ND	ND	0.81	NA	ND	ND
Isopropylbenzene	ND	NA	ND	ND	ND	NA	ND	ND
n-Propylbenzene	ND	NA	ND	ND	ND	NA	ND	ND
1,2,4-Trimethylbenzene	ND	NA	ND	ND	ND	NA	ND	ND
1,3,5-Trimethylbenzene	ND	NA	ND	ND	ND	NA	ND	ND
Total Xylenes (mixed isomers)	3.9	NA	ND	ND	6.1	NA	ND	ND
Geochemical Parameter for Distribution (mg/L)								
Sulfate, using EPA 300.0	23	16	NA	NA	15	10	NA	NA

Notes:

1) **Bold** denotes exceedance of applicable Method 1 GW-2 or the GW-3 criteria (updated with 12/14/2007 MCP revisions).
2) 12/14/2007 MCP revisions: GW-2 for ethylbenzene from 30,000 to 20,000 ug/L and GW-3 for xylenes from 500 to 5,000 ug/L.
3) ND = Non-Detect at Respective Reporting Limit
4) NA = Not Available or Not Measured
5) Date of ISCO Injection: May 30 - June 3, 2006
6) Water level would not stabilize and well went dry.

Table 5-1
Comparisons of Exposure Scenarios in Various HHRAAs Conducted at the Reichhold Site
Reichhold, Inc., Andover, Massachusetts

Timeframe	Parcel Parcel I FMA		Parcel I Former LFA		Parcel II Former EBA (non-wetlands)		Parcel II Former EBA (wetlands)		Parcel III
MCP RA Method	**Method 3**		**Method 3**		**Method 3**		**Method 2**		**Method 1**
	Receptor	**Media (Exposure Routes)**	**Receptor**	**Media (Exposure Routes)**	**Receptor**	**Media (Exposure Routes)**	**Receptor**	**Media (Exposure Routes)**	
Current	Industrial Worker	Soil (Ing/Derm/Inh) Indoor Air							(1)
	Utility Worker	Soil (Ing/Derm/Inh) GW (Derm/Inh)					Utility Worker	Soil (Ing/Derm/Inh)	
	River Recreational Adult	Sed (Derm) SW (Ing/Derm) Fish (Ing)							
	River Recreational Youth	Sed (Derm) SW (Ing/Derm) Fish (Ing)							
			Trespasser	Soil (Ing/Derm/Inh)	Trespasser	Soil (Ing/Derm/Inh)	Trespasser	Soil (Ing/Derm/Inh)	
Future	Onsite Recreational Adult	Soil (Ing/Derm/Inh) Demolished Concrete (Ing/Derm/Inh) Indoor Air	Recreational Adult	Soil (Ing/Derm/Inh)	Recreational Adult	Soil (Ing/Derm/Inh)	Recreational Adult	Soil (Ing/Derm/Inh)	(1)
	Onsite Recreational Youth	Soil (Ing/Derm/Inh) Demolished Concrete (Ing/Derm/Inh) Indoor Air	Recreational Youth	Soil (Ing/Derm/Inh)	Recreational Youth	Soil (Ing/Derm/Inh)	Recreational Youth	Soil (Ing/Derm/Inh)	
	Industrial Worker	Soil (Ing/Derm/Inh) Demolished Concrete (Ing/Derm/Inh) Indoor Air	Industrial/Commercial Worker	Soil (Ing/Derm/Inh)	Industrial/Commercial Worker	Soil (Ing/Derm/Inh)	Industrial Worker	Soil (Ing/Derm/Inh)	
	Construction Worker	Soil (Ing/Derm/Inh) Demolished Concrete (Ing/Derm/Inh) GW (Derm/Inh)					Construction Worker	Soil (Ing/Derm/Inh)	
							Trespasser	Soil (Ing/Derm/Inh)	
Exposure Media	Soil Groundwater Concrete Sediment Surface water Fish		Soil Groundwater (no risk estimate)[2]		Soil Groundwater (no risk estimate)[3]		Soil Groundwater (no risk estimate)[4]		Soil Groundwater[4]

Note:
[1] Since Method 1 Risk Assessment was conducted, the detailed discussion of potential receptors was provided in the report.
However, the receptors expected to be present at Parcel III are consistent with other portions of the Reichhold site (e.g., Trespassers and Recreators)
[2] Risk estimates were not quantified because Former LFA is classified as a non-potential drinking water source area (NPDWSA).
[3] Chemicals of concern were not identified in groundwater; therefore, risk estimates were not quantified.
[4] Groundwater data indicate no exceedances of MADEP standards.
Derm - Dermal
EBA = Equalization Basin Area
FMA = Former Manufacturing Area
GW = Groundwater
HHRAA = Human Health Risk Assessment Addendum
Ing - Ingestion
Inh - Inhalation
LFA = Landfill Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
RA = Risk Assessment
SW = Surface Water

Table 5-2
Summary of Quantitative Risk Estimates in the HHRAAs
Reichhold, Inc., Andover, Massachusetts

Parcel	Class of RAO	Method of RA	Safety Risk	Public Welfare Risk	ELCR	HI	Conclusion
Parcel I Former LFA	A-3	Method 3	NSR	NSR	-	-	NSR
Current Trespasser					4E-09	0.008	
Future Recreational Adult					2E-08	0.01	
Future Recreational Youth					9E-09	0.01	
Future Industrial/Commercial Worker					8E-08	0.03	
Parcel II Former EBA (non-wetlands)	A-3	Method 3	NSR	NSR	-	-	NSR
Current Trespasser					-	0.000002	
Future Recreational Adult					-	0.000003	
Future Recreational Youth					-	0.000003	
Future Industrial/Commercial Worker					-	0.00001	
Parcel II Former EBA (wetlands)	A-3	Method 2	NSR	NSR	-	-	NSR
Parcel III	A-2	Method 1	NSR	NSR	-	-	NSR
Parcel I FMA		Method 3			**-**	**-**	Risk estimates for future indoor air pathway exceed target levels based on groundwater data; current scenarios and other future media within MADEP target levels
Current Industrial Worker					4E-09	0.006	
Current/Future Utility Worker					2E-09	0.003	
Current/Future River Recreational Adult					NA	0.2	
Current/Future River Recreational Youth					NA	0.3	
Future Industrial Worker					9E-06	13	
Future Construction Worker					2E-07	0.4	
Future Onsite Recreational Adult					8E-06	13	
Future Onsite Recreational Youth					8E-06	13	

Note:
EBA = Equalization Basin Area
ELCR = Excess Lifetime Cancer Risk
FMA = Former Manufacturing Area
HHRAA = Human Health Risk Assessment Addendum
HI = Hazard Index
LFA = Landfill Area
MADEP = Massachusetts Department of Environmental Protection
NA = Not Available
NSR = No Significant Risk
RA = Risk Assessment
RAO = Response Action Outcome

Table 5-3
Comparison of Exposure Factors and Assumptions: Trespasser and Onsite Recreational Youth Scenarios
Reichhold, Inc., Andover, Massachusetts

Exposure Variable	Exposure Factors		Reference/Comments
	Trespasser [1]	Onsite Recreational Youth [2]	
Incidental soil ingestion, mg/day	50	50	default value, > 6 years old (MADEP, 1995)
Soil-to-skin adherence factor, mg/cm^2	0.14	0.35	Trespasser - Tech guidance, value for youth trespasser 11 to 18 years of age (MADEP, 2002); Recreational Youth - Tech guidance, value for child resident/child recreational (MADEP, 2002).
Skin surface in contact with soil, cm^2 - day	2,928	4,600	Tresapasser - Tech guidance, value for youth trespasser 11 to 18 years of age. Parts of the body include hands, forearms, and feet. (MADEP, 2002); Recreational Youth - Value for recreational youth 7 to 18 years of age. Parts of the body include head, hands, forearms, and lower legs. (MADEP, 1995).
Airborne particulate concentration, ug/m^3	32	32	MADEP, 1995
Exposure frequency soil, days/yr	43	91	Trespasser - 2 days/week in June-Aug and 1 day/week in April, May, September, and October. Recreational Youth - 3 days/week, April-Oct., best professional judgment
Exposure time, hrs/day	4	3	best professional judgment
Exposure duration, yrs	7	11	Trespasser - 11 to 18 years of age, best professional judgment; Recreational Youth - 7 to 18 years of age, best professional judgment
Relative Absorption Factor, %	Chemical-specific	Chemical-specific	MADEP, 1995
Body weight, kg	52	43	average of male and female, (MADEP, 1995)[3]
Averaging time, noncancer	2,555	4,015	Value calculated as ED x 365 days (MADEP, 1995)
Averaging time, cancer	27,375	27,375	MADEP, 1995

Note:
[1] Trespasser is assumed to be an adolescent (11 to 18 years of age).
[2] Recreational youth is assumed to be an adolescent (7 to 18 years of age).
ED = Exposure Duration
MCP = Massachusetts Contingency Plan
MADEP = Massachusetts Department of Environmental Protection

References:
Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (MADEP, 1995).
Supplemental Guidance – Weighted Skin-Soil Adherence Factors (MADEP, 2002).

Table 5-4
Identification of Site-Wide Surface Soil Exposure Point Concentrations
Reichhold, Inc., Andover, Massachusetts

Chemical	CAS Number	Parcel I FMA Surface Soil		Parcel I Former LFA Surface Soil		Parcel II Former EBA (wetlands) Surface Soil		Parcel III Surface Soil	Parcel II Former EBA (non-wetlands) Surface Soil		Site-wide Surface Soil
		Maximum Detected Concentration	Exposure Point Concentration (Average)	Maximum Detected Concentration	Exposure Point Concentration (Average)	Maximum Detected Concentration	Exposure Point Concentration (Average)	Maximum Detected Concentration	Maximum Detected Concentration	Exposure Point Concentration (Average)	Site-wide EPC [1]
1,2,4-Trimethylbenzene	95-63-6	200	11					0.036			11
1,3,5-Trimethylbenzene	108-67-8	81	4.7					0.05			4.7
2-Butanone	78-93-3							0.016			0.016
Acetone	67-64-1	0.1	0.92	0.061	0.046	0.78	0.35	0.18			0.92
Benzene	71-43-2							0.0016			0.0016
Ethylbenzene	100-41-4	15	0.92	2.8	0.26			0.011	0.013	0.0036	0.92
Isopropylbenzene	98-82-8	0.23	0.11					0.012			0.11
n-Butylbenzene	104-51-8	26	1.4					0.0016			1.4
n-Propylbenzene	103-65-1	6.2	0.37					0.0068			0.37
Naphthalene	91-20-3	19	1.1					0.001	0.014	0.0064	1.1
Methyl tert butyl ether	1634-04-4	0.203	0.19								0.19
Methylene chloride	75-09-2	0.146	0.71	0.052	0.034			0.011			0.71
o-Xylene	95-47-6	12	1.4	2.4	0.27			0.016			1.4
p-Isopropyltoluene	99-87-6	0.216	0.10					0.0046			0.10
p/m-Xylene	OER-100-48	77	6.7	15	1.67			0.046			6.7
Toluene	108-88-3							0.057			0.057
Total Xylenes	1330-20-7	0.709	0.22			5.9	1.213375		0.078	0.012	1.2
2,4-Dimethylphenol	105-67-9	0.42	0.19	0.73	2.0						2.0
3-Methylphenol/4-Methylphenol	OER-101-66	1.3	0.28			1.7	0.92				0.92
Phenol	108-95-2	4.5	0.56	1.2	1.0	1.7	0.955		0.97	0.224	1.0
bis(2-Ethylhexyl)phthalate	117-81-7	0.42	0.26								0.26
Barium	7440-39-3	77	26								26
Cadmium	7440-43-9	5.5	1.1	62.5	31				0.24	0.14	31
Copper	7440-50-8	250	22	28.1	16.4				11.3	8.43	22
Iron	7439-89-6	31000	10,333	10,800	8,470				11,600	8,455	10,333
Lead	7439-92-1	76		130	66			71.6	6.76	5.01	72
Silver	7440-22-4	0.6	0.29								0.29
Zinc	7440-66-6	590	131	4,230	2,124			43.8	29	21.33	2,124
2-Methylphenol	95-48-7			0.64	0.98	1.7	0.93				0.98
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1			3	4.0						4.0
Chloromethane	74-87-3							0.0098			0.0098
Trichlorofluoromethane	75-69-4							0.0036			0.0036

Note:
Units are presented in mg/kg
[1] Site-wide Exposure Point Concentrations (EPCs) are the maximum values of EPCs from portions of the Reichhold site.
EBA = Equalization Basin Area
FMA = Former Manufacturing Area
LFA = Landfill Area

Table 5-5
Identification of Site-Wide Total Soil Exposure Point Concentrations
Reichhold, Inc., Andover, Massachusetts

Chemical	CAS Number	Parcel I FMA Total Soil		Parcel II Former EBA (wetlands) Total Soil		Site-wide Total Soil
		Maximum Detected Concentration	Exposure Point Concentration (Average)	Maximum Detected Concentration	Exposure Point Concentration (Average)	Site-wide EPC [1]
1,2,4-Trimethylbenzene	95-63-6	2,080	137			137
1,2-Dichlorobenzene	95-50-1	39.4	2.3			2.3
1,3,5-Trimethylbenzene	108-67-8	634.9	46			46
1,4-Dichlorobenzene	106-46-7	0.003	1.3			1.3
2-Butanone	78-93-3	0.045	10			10
4-Methyl-2-pentanone	108-10-1	0.052	8.4			8.4
Acetone	67-64-1	37	8.7	0.78	0.35	8.7
Benzene	71-43-2	0.009	0.89			0.89
Carbon disulfide	75-15-0	0.002	1.5			1.5
Chlorobenzene	108-90-7	54.2	1.8			1.8
Ethylbenzene	100-41-4	4,200	62			62
Isopropylbenzene	98-82-8	35.7	1.9			1.9
n-Butylbenzene	104-51-8	120	10			10
n-Propylbenzene	103-65-1	62.8	4.1			4.1
Naphthalene	91-20-3	181.8	9.5			9.5
Methyl tert butyl ether	1634-04-4	0.203	1.1			1.1
Methylene chloride	75-09-2	0.146	5.1			5.1
o-Xylene	95-47-6	140	11			11
p-Isopropyltoluene	99-87-6	10	1.7			1.7
p/m-Xylene	OER-100-48	738.6	62			62
sec-Butylbenzene	135-98-8	4.1	1.2			1.2
Styrene	100-42-5	140	5.6			5.6
Toluene	108-88-3	60	1.9			1.9
Total Xylenes	1330-20-7	2,100	121	5.9	1.21	121
2,4-Dimethylphenol	105-67-9	1.3	0.42			0.42
3-Methylphenol/4-Methylphenol	OER-101-66	2.6	0.55	1.7	0.92	0.92
Phenol	108-95-2	560	13	1.7	0.955	13
2-Methylnaphthalene	91-57-6	11.5	1.2			1.2
bis(2-Ethylhexyl)phthalate	117-81-7	0.42	0.28			0.28
Dibenzofuran	132-64-9	0.429	0.30			0.30
Phenanthrene	85-01-8	4.34	0.61			0.61
Arsenic	7440-38-2	22	7.8			7.8
Barium	7440-39-3	77	22			22
Cadmium	7440-43-9	43.8	2.9			2.9
Chromium	7440-47-3	42	17			17
Copper	7440-50-8	250	20			20
Iron	7439-89-6	31,000	9,485			9,485
Lead	7439-92-1	227	23			23
Silver	7440-22-4	0.6	0.30			0.30
Zinc	7440-66-6	6,000	573			573
2-Methylphenol	95-48-7			1.7	0.93	0.93

Note:
Units are presented in mg/kg
[1] Site-wide Exposure Point Concentrations (EPCs) are the maximum values of EPCs from portions of the Reichhold site.
EBA = Equalization Basin Area
FMA = Former Manufacturing Area

Table 5-6

Comparison of Groundwater to Applicable or Suitably Analogous Standards

Reichhold, Inc., Andover, Massachusetts

Analyte	CAS Number	Applicable or Suitably Analogous Standards: MMCL/ORSG	Applicable or Suitably Analogous Standards: Method 3 UCL	Units	Parcel I FMA: Minimum Detected Concentration	Parcel I FMA: Maximum Detected Concentration	Parcel I FMA: EPC	Parcel I Former LFA: Minimum Detected Concentration	Parcel I Former LFA: Maximum Detected Concentration	Parcel II Former EBA (non-wetlands): Minimum Detected Concentration	Parcel II Former EBA (non-wetlands): Maximum Detected Concentration	Parcel II Former EBA (wetlands): Maximum Detected Concentration	Parcel III: Minimum Detected Concentration	Parcel III: Maximum Detected Concentration
1,1-Dichloropropene	563-58-6	NA	NA	ug/L	--[1]	--	--	1.4	5.8	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	NA	NA	ug/L	0.5	5,090	482	1.6	66	--	--	--	--	--
1,2-Dichlorobenzene	95-50-1	600	20,000	ug/L	0.6	20	8.3	1.3	640	--	--	--	--	--
1,2-Dichloroethane	107-06-2	5	100,000	ug/L	0.8	1.8	2.9	--	--	--	--	--	--	--
1,2-Dichloropropane	78-87-5	5	100,000	ug/L	--	--	--	--	--	1.4	1.4	1.7	--	--
1,3,5-Trimethylbenzene	108-67-8	NA	NA	ug/L	1.4	1,800	126	3.4	32	--	--	--	--	--
1,3-Dichlorobenzene	541-73-1	NA	100,000	ug/L	0.6	4.6	8.8	--	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	5	80,000	ug/L	0.6	86	13	1.2	340	--	--	--	--	--
2,4-Dichlorophenol	120-83-2	NA	100,000	ug/L	23	23	3	--	--	--	--	--	--	--
2,4-Dimethylphenol	105-67-9	NA	100,000	ug/L	4	19	4.5	--	--	--	--	--	--	--
2-Butanone (Methyl ethyl ketone)	78-93-3	4,000	100,000	ug/L	--	--	--	--	--	--	--	54	--	--
2-Methylnaphthalene	91-57-6	NA	100,000	ug/L	1.4	1.4	0.43	--	--	--	--	--	--	--
3-Methylphenol/4-Methylphenol	OER-101-66	NA	NA	ug/L	6	6	2.6	--	--	--	--	--	--	--
4-Methyl-2-pentanone	108-10-1	350	100,000	ug/L	765	765	37	17	93	40	120	100	--	--
Acetone	67-64-1	6,300	100,000	ug/L	5.6	9	29	--	--	58.4	331	140	--	--
Arsenic	7440-38-2	10	9,000	ug/L	9	160	52	2.7	90.3	--	--	--	2.4	2.4
Barium	7440-39-3	2,000	100,000	ug/L	5.3	27	16	--	--	--	--	--	--	--
Benzene	71-43-2	5	100,000	ug/L	0.5	109	5.5	1.1	1,600	--	--	--	--	--
Benzo(a)pyrene	50-32-8	0.2	5,000	ug/L	0.3	0.3	0.2	--	--	--	--	--	--	--
Benzo(b)fluoranthene	205-99-2	NA	4,000	ug/L	0.3	0.3	0.2	--	--	--	--	--	--	--
Benzo(ghi)perylene	191-24-2	NA	500	ug/L	0.2	0.3	0.18	--	--	--	--	--	--	--
Bromomethane	74-83-9	10	8,000	ug/L	--	--	--	1.1	3	--	--	--	--	--
Chlorobenzene	108-90-7	100	10,000	ug/L	0.6	1,580	44	2.6	1,100	--	--	--	--	--
Chloromethane	74-87-3	NA	NA	ug/L	--	--	--	1.1	1.2	1.6	1.6	--	--	--
cis-1,2-Dichloroethene	156-59-2	70	100,000	ug/L	--	--	--	2.1	2.1	--	--	--	--	--
Dibenzo(a,h)anthracene	53-70-3	NA	NA	ug/L	0.4	0.4	0.18	--	--	--	--	--	--	--
Ethyl ether	60-29-7	NA	NA	ug/L	--	--	--	--	--	--	--	3.1	--	--
Ethylbenzene	100-41-4	700	100,000	ug/L	0.7	15,600	532	1.1	5,200	1.4	11	97	--	--
Fluorene	86-73-7	NA	400	ug/L	0.3	0.3	0.15	--	--	--	--	--	--	--
Formaldehyde	50-00-0	NA	NA	ug/L	6.27	6.27	4.4	--	--	--	--	--	--	--
Indeno(1,2,3-cd)Pyrene	193-39-5	NA	1,000	ug/L	0.4	0.5	0.28	--	--	--	--	--	--	--
Iron	7439-89-6	NA	NA	ug/L	12	9,500	4,258	--	--	--	--	--	--	--
Isopropylbenzene	98-82-8	NA	NA	ug/L	0.6	95	22	1.2	78	1.5	10	2.6	--	--
Manganese	7439-96-5	NA	NA	ug/L	160	3,500	1,153	--	--	--	--	--	--	--
Methyl tert butyl ether	1634-04-4	70	100,000	ug/L	0.6	10	4.2	--	--	--	--	--	--	--
Naphthalene	91-20-3	140	100,000	ug/L	1.2	263	31	1.1	15	--	--	--	--	--
n-Butylbenzene	104-51-8	NA	NA	ug/L	2.4	58	6.1	--	--	--	--	--	--	--
n-Propylbenzene	103-65-1	NA	NA	ug/L	0.6	109	19	1.6	23	--	--	--	--	--
o-Xylene	95-47-6	NA	100,000	ug/L	0.6	1,900	116	1	58	--	--	--	--	--
p/m-Xylene	OER-100-48	NA	100,000	ug/L	0.5	6,900	647	--	--	--	--	--	--	--
Phenanthrene	85-01-8	NA	100,000	ug/L	0.5	0.5	0.2	--	--	--	--	--	--	--
Phenol	108-95-2	NA	100,000	ug/L	47	74	5.3	25.9	1,100	--	--	--	--	--
p-Isopropyltoluene	99-87-6	NA	NA	ug/L	0.5	156	14	--	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	NA	NA	ug/L	3.4	3.4	4.1	--	--	--	--	--	--	--
Styrene	100-42-5	100	60,000	ug/L	115	115	5.4	--	--	--	--	--	--	--
Tetrahydrofuran	109-99-9	1,300	NA	ug/L	--	--	--	--	--	--	--	74	--	--
tert-Butylbenzene	98-06-6	NA	NA	ug/L	0.9	0.9	26	1	2.6	--	--	--	--	--
Tertiary-Amyl Methyl Ether	994-05-8	90	NA	ug/L	0.6	5.6	6.5	--	--	--	--	--	--	--
Toluene	108-88-3	1,000	100,000	ug/L	1.2	63	7.3	2.4	310	2	14	9.3	--	--
Total Xylenes	1330-20-7	10,000	100,000	ug/L	--	--	--	2.5	24,000	4.4	39	1,400	--	--
Zinc	7440-66-6	NA	50,000	ug/L	5.9	22	19	1,300	1,300	--	--	--	--	--

Notes:
Shaded cell indicated exceedance of MMCL or ORSG.
-- Not detected or analyzed
EBA = Equalization Basin Area
EPC = Exposure point concentration
FMA = Former Manufacturing Area
LFA = Landfill Area
Method 3 UCL = Massachusetts Contingency Plan (MCP, 310 CMR 40.0000) Method 3 Risk Characterization
MMCL = Massachusetts Maximum Contaminant Level (MMCL, 310 CMR 22.00).
NA = Not available
ORSG - Office of Research and Standards Massachusetts Drinking Water Guidelines.
Upper Concentration Limit (310 CMR 40.0996(7))
Total xylene value used as surrogate for o-xylene and p/m-xylene

Table 5-7
Summary of Estimated Cumulative Health Risks
Reichhold, Inc., Andover, Massachusetts

Receptor	Media[1]	Exposure Route	ELCR	Hazard Index
Current Industrial Worker[2]	Surface Soil at FMA	Ingestion	2E-10	0.0008
		Dermal Contact	2E-11	0.0001
		Inhalation	3E-09	0.005
		Soil Total	**4E-09**	**0.006**
	Groundwater - Indoor Air	Inhalation	NA	0.000002
	Receptor Total		**4E-09**	**0.006**
Current/Future River Recreational Adult	Sediment	Dermal Contact	NA	0.0008
	Surface Water	Ingestion	NA	0.00000002
		Dermal Contact	NA	0.0000008
	Fish	Ingestion	NA	0.2
	Receptor Total		**NA**	**0.2**
Current/Future River Recreational Youth	Sediment	Dermal Contact	NA	0.001
	Surface Water	Ingestion	NA	0.00000004
		Dermal Contact	NA	0.000001
	Fish	Ingestion	NA	0.3
	Receptor Total		**NA**	**0.3**
Future Industrial Worker	Site-wide Surface Soil	Ingestion	2E-10	0.01
		Dermal Contact	2E-11	0.002
		Inhalation	2E-07	0.02
		Soil Total	**2E-07**	**0.04**
	Demolished Concrete	Ingestion	NA	0.002
		Dermal Contact	NA	0.0004
		Inhalation	7E-10	0.003
		Concrete Total	**7E-10**	**0.006**
	Groundwater - Indoor Air	Inhalation	8E-06	13
	Receptor Total		**8E-06**	**13**
Future Construction Worker	Site-wide Total Soil	Ingestion	3E-08	0.02
		Dermal Contact	1E-08	0.01
		Ingestion of Inhaled Particulates	3E-09	0.002
		Inhalation of Particulates	6E-08	0.1
		Inhalation of Volatiles	3E-10	0.03
		Soil Total	**1E-07**	**0.2**
	Demolished Concrete	Ingestion	NA	0.006
		Dermal Contact	NA	0.005
		Ingestion of Inhaled Particulates	NA	0.0005
		Inhalation of Particulates	1E-10	0.02
		Inhalation of Volatiles	NA	0.0000002
		Concrete Total	**1E-10**	**0.04**
	Groundwater - Excavation	Dermal Contact	3E-08	0.01
		Inhalation	2E-08	0.1
		Groundwater Total	**5E-08**	**0.1**
	Receptor Total		**2E-07**	**0.3**
Future Onsite Recreational Adult	Site-wide Surface Soil	Ingestion	5E-11	0.003
		Dermal Contact	2E-11	0.002
		Inhalation	6E-08	0.005
		Soil Total	**6E-08**	**0.01**
	Demolished Concrete	Ingestion	NA	0.0005
		Dermal Contact	NA	0.0004
		Inhalation	2E-10	0.0007
		Concrete Total	**2E-10**	**0.002**
	Groundwater - Indoor Air	Inhalation	8E-06	13
	Receptor Total		**8E-06**	**13**
Future Onsite Recreational Youth	Site-wide Surface Soil	Ingestion	3E-11	0.005
		Dermal Contact	4E-11	0.01
		Inhalation	2E-08	0.005
		Soil Total	**2E-08**	**0.02**
	Demolished Concrete	Ingestion	NA	0.0009
		Dermal Contact	NA	0.002
		Inhalation	6E-11	0.0007
		Concrete Total	**6E-11**	**0.004**
	Groundwater - Indoor Air	Inhalation	8E-06	13
	Receptor Total		**8E-06**	**13**

Note:
[1] Estimated ELCRs and hazard indices for site-wide soil are calculated on a site-wide basis; calculations are provided in Attachment C. Estimated ELCRs and hazard indices for all other media were obtained from the FMA HHRAA.
[2] Potentially complete pathways for Current Industrial Workers are only identified for FMA.
ELCR = Excess lifetime cancer risk
FMA = Former Manufacturing Area
HHRAA = Human Health Risk Assessment Addendum
NA = Not available

Table 5-8
Summary of July and November, 2011 Passive Diffusion Bag Pore-Water Results
Reichhold Andover

Parameter	MCP Numerical Standards December, 2009		Pore-Water Results							
			Monitoring Event # 1 (7/1/2011)			Monitoring Event # 2 (11/10/2011)				
			upstream	near former pump house	downstream	11 ft upstream	0 ft (origin)	10 ft offshore	20 ft downstream	45 ft downstream
	Lowest Eco-Based Criteria (µg/L)	MA DEP Method 1 GW-3 Values (µg/L)	SEDPDB-1 (µg/L)	SEDPDB-3 Pore Water Result (µg/L)	SEDPDB-2 (µg/L)	SED-PDB-UG1 (µg/L)	SED-PDB-2 (µg/L)	SED-PDB-CG (µg/L)	SED-PDB-DG1 (µg/L)	SED-PDB-DG2 (µg/L)
Benzene	460	10000	ND	ND	3.2	ND	0.8	ND	2.4	ND
n-Butylbenzene	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	38	1000	ND	5.5	37	ND	3.1	ND	51	1.7
Chloromethane	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	78	2000	ND	ND	2.0	ND	ND	ND	9.2	0.9
1,4-Dichlorobenzene	310	8000	ND	0.6	0.7	ND	ND	ND	1.7	ND
cis-1,2-Dichloroethene	14000	50000	ND	ND	0.6	ND	ND	ND	0.7	ND
1,2-Dichloropropane	25000	50000	ND	ND	ND	ND	ND	ND	6.9	ND
Acetone	3400	50000	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloropropene	NA	NA	ND	ND	ND	ND	ND	ND	0.6	ND
Ethylbenzene	181	5000	ND	ND	1430	ND	45	ND	1310	3.7
Isopropylbenzene	NA	NA	ND	0.8	7.9	ND	2.8	ND	8.7	ND
Naphthalene	72	20000	ND	ND	18	ND	2.1	ND	ND	ND
n-Propylbenzene	NA	NA	ND	ND	4.2	ND	1.7	ND	0.8	ND
Toluene	1400	40000	ND	ND	65	ND	0.7	ND	736	ND
1,2,3-Trichloropropane	NA	NA	ND	ND	ND	ND	ND	ND	2.1	ND
1,2,4-Trimethylbenzene	NA	NA	ND	ND	109	ND	12	ND	3.2	ND
1,3,5-Trimethylbenzene	NA	NA	ND	ND	30	ND	4.6	ND	1.1	ND
Vinyl chloride	41000	50000	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (mixed isomers)	200	5000	ND	ND	**7064**	ND	244	ND	**7170**	24
Methyl isobutyl ketone	200000	50000	ND	ND	ND	ND	ND	ND	11	ND

Notes:
1) **Bold** greater than Method 1 GW-3 criteria
2) ND = Not Detected
3) NA = Not Available
4) Shaded columns include data from samples SEDPDB-2 (7/1/2011) and SED-PDB-2 (11/10/2011). Both are from the same location during successive events.
5) Monitoring Events #1 (7/1/2011) and #2 (11/10/2011) Analytics Laboratory data packages #70358 and # 71497, respectively.
6) MA DEP Method 1 GW-3 Numerical Standards are developed from "lowest ecologically-based criteria" selected from the literature: these are "final" values from the EPA AQUIRE ecotoxicity database for xylene and ethylbenzene. A groundwater attenuation factor of 2.5, 25, or 100 times is applied depending on the physicochemical properties (ie. Koc) of the constituent. In addition, a groundwater to surface water dilution factor of 10 times is applied. The target groundwater value adjusted for attenuation and dilution is then compared against AWQC ceiling values and practical quantitation limits (PQL). A GW-3 standard is then selected from the rounded result of the lowest of the two former values or the PQL, if higher. In summary, GW-3 values for ethylbenzene and xylene (mixed isomers) involve "lowest ecologically-based criteria" from AQUIRE adjusted for attenuation and dilution.
7) PDB event #1 installation 6/17/2011 and #2 installation 10/19/2011.T
8) The discharge area evaluated during Monitoring Event #2 involved shoreline measuring 56 feet by 10 feet or approximately 560 square feet.

Attachment A - BWSC Form 104

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC104

RESPONSE ACTION OUTCOME (RAO) STATEMENT

Pursuant to 310 CMR 40.1000 (Subpart J)

Release Tracking Number

3 - 208

For sites with multiple RTNs, enter the Primary RTN above.

A. SITE LOCATION:

1. Site Name/Location Aid: REICHHOLD CHEMICALS INC FMR

2. Street Address: 77 LOWELL JUNCTION RD

3. City/Town: ANDOVER   4. ZIP Code: 05544

☑ 5. Check here if a Tier Classification Submittal has been provided to DEP for this disposal site.   4720465

☐ a. Tier IA ☐ b. Tier IB ☐ c. Tier IC ☑ d. Tier II   677859

6. If a Tier I Permit has been issued, provide Permit Number: ______________________

B. THIS FORM IS BEING USED TO: (check all that apply)

1. List Submittal Date of RAO Statement (if previously submitted): __________ mm/dd/yyyy

☐ 2. Submit a **Response Action Outcome (RAO) Statement**

☐ a. Check here if this RAO Statement covers additional Release Tracking Numbers (RTNs). RTNs that have been previously linked to a Tier Classified Primary RTN do not need to be listed here.

b. Provide additional Release Tracking Number(s) covered by this RAO Statement. ___ - ______ ___ - ______

☐ 3. Submit a **Revised Response Action Outcome Statement**

☐ a. Check here if this Revised RAO Statement covers additional Release Tracking Numbers (RTNs), not listed on the RAO Statement or previously submitted Revised RAO Statements. RTNs that have been previously linked to a Tier Classified Primary RTN do not need to be listed here.

b. Provide additional Release Tracking Number(s) covered by this RAO Statement. ___ - ______ ___ - ______

☑ 4. Submit a **Response Action Outcome Partial (RAO-P) Statement**

Check above box, if any Response Actions remain to be taken to address conditions associated with this disposal site having the Primary RTN listed in the header section of this transmittal form. This RAO Statement will record only an RAO-Partial Statement for that RTN. A final RAO Statement will need to be submitted that references all RAO-Partial Statements and, if applicable, covers any remaining conditions not covered by the RAO-Partial Statements.

Also, specify if you are an Eligible Person or Tenant pursuant to M.G.L. c. 21E s.2, and have no further obligation to conduct response actions on the remaining portion(s) of the disposal site:

☐ a. Eligible Person ☐ b. Eligible Tenant

☐ 5. Submit an optional **Phase I Completion Statement** supporting an RAO Statement

☐ 6. Submit a **Periodic Review Opinion evaluating the status of a Temporary Solution** for a Class C-1 RAO Statement, as specified in 310 CMR 40.1051 (Section F is optional)

☐ 7. Submit a **Retraction** of a previously submitted **Response Action Outcome Statement** (Sections E & F are not required)

(All sections of this transmittal form must be filled out unless otherwise noted above)

C. DESCRIPTION OF RESPONSE ACTIONS: (check all that apply; for volumes, list cumulative amounts)

- ☐ 1. Assessment and/or Monitoring Only
- ☐ 2. Temporary Covers or Caps
- ☐ 3. Deployment of Absorbent or Containment Materials
- ☐ 4. Treatment of Water Supplies
- ☐ 5. Structure Venting System
- ☐ 6. Engineered Barrier
- ☐ 7. Product or NAPL Recovery
- ☐ 8. Fencing and Sign Posting
- ☐ 9. Groundwater Treatment Systems
- ☐ 10. Soil Vapor Extraction
- ☑ 11. Bioremediation
- ☐ 12. Air Sparging
- ☑ 13. Monitored Natural Attenuation
- ☐ 14. In-situ Chemical Oxidation

☑ 15. Removal of Contaminated Soils

☐ a. Re-use, Recycling or Treatment ☐ i. On Site Estimated volume in cubic yards

☐ ii. Off Site Estimated volume in cubic yards

iia. Facility Name: Town: State:

iib. Facility Name: Town: State:

iii. Describe:

☑ b. Landfill

☐ i. Cover Estimated volume in cubic yards

Facility Name: Town: State:

☑ ii. Disposal Estimated volume in cubic yards **1,160**

Facility Name: **W.M.TURNKEYLF.-SOILS/CONC** Town: **ROCHESTER** State: **NH**

☐ 16. Removal of Drums, Tanks or Containers:

a. Describe Quantity and Amount:

b. Facility Name: Town: State:

c. Facility Name: Town : State:

☑ 17. Removal of Other Contaminated Media:

a. Specify Type and Volume: **976 TONS (574 C.Y) CONTAMINATED SOILS; 2,650 TONS (1559 C.Y.) SOILS/RESINS**

b. Facility Name: **E.Q.** Town: **WAYNE** State: **MI**

c. Facility Name: **W.M. CROSSROADS L.F.** Town: **NORRIDGEWOCK** State: **ME**

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC104

RESPONSE ACTION OUTCOME (RAO) STATEMENT

Pursuant to 310 CMR 40.1000 (Subpart J)

Release Tracking Number
3 - **208**

C. DESCRIPTION OF RESPONSE ACTIONS (cont.): (check all that apply; for volumes, list cumulative amounts)

☑ 18. Other Response Actions:

Describe: **ENHANCED INTRINSIC BIOREM. OF G.W (ORC, O2 RELEASE EHC, ISCO (SODIUM PERSULFATE) AND G.W. MONITORING); 4,510 LBS ORC; 4,500 LBS EHC; 12,500 SOD. PERSULFATE/2,250 SOD. HYDROX**

☑ 19. Use of Innovative Technologies:

Describe: **ORC POWDER AND SLURRIES IN EXCAVATIONS AND G.W.; O2 RELEASE EHC; AND ISCO**

D. SITE USE:

1. Are the response actions that are the subject of this submittal associated with the *redevelopment, reuse* or the *major expansion of the current use* of property(ies) impacted by the presence of oil and/or hazardous materials?

☐ a. Yes ☐ b. No ☑ c. Don't know

2. Is the property a *vacant or under-utilized commercial or industrial* property ("a brownfield property")?

☑ a. Yes ☐ b. No ☐ c. Don't know

3. Will funds from a state or federal brownfield incentive program be used on one or more of the property(ies) within the disposal site?

☐ a. Yes ☐ b. No ☑ c. Don't know If Yes, identify program(s):

4. Has a Covenant Not to Sue been obtained or sought?

☐ a. Yes ☐ b. No ☑ c. Don't know

5. Check all applicable categories that apply to the person making this submittal: ☐ a. Redevelopment Agency or Authority

☐ b. Community Development Corporation ☐ c. Economic Development and Industrial Corporation

☐ d. Private Developer ☐ e. Fiduciary ☐ f. Secured Lender ☐ g. Municipality

☐ h. Potential Buyer (non-owner) ☑ i. Other, describe: **CURRENT OWNER**

This data will be used by MassDEP for information purposes only, and does not represent or create any legal commitment, obligation or liability on the part of the party or person providing this data to MassDEP.

E. RESPONSE ACTION OUTCOME CLASS:

Specify the Class of Response Action Outcome that applies to the disposal site, or site of the Threat of Release.
Select **ONLY** one Class.

☐ **1. Class A-1 RAO**: Specify one of the following:

☐ a. Contamination has been reduced to background levels. ☐ b. A Threat of Release has been eliminated.

☐ **2. Class A-2 RAO:** You **MUST** provide justification that reducing contamination to or approaching background levels is infeasible.

☑ **3. Class A-3 RAO**: You **MUST** provide an implemented Activity and Use Limitation (AUL) and justification that reducing contamination to or approaching background levels is infeasible.

☐ **4. Class A-4 RAO**: You **MUST** provide an implemented AUL, justification that reducing contamination to or approaching background levels is infeasible, and justification that reducing contamination to less than Upper Concentration Limits (UCLs) 15 feet below ground surface or below an Engineered Barrier is infeasible. If the Permanent Solution relies upon an Engineered Barrier, you must provide or have previously provided a Phase III Remedial Action Plan that justifies the selection of the Engineered Barrier.

E. RESPONSE ACTION OUTCOME CLASS (cont.):

☐ **5. Class B-1 RAO: Specify one of the following:**

☐ a. Contamination is consistent with background levels ☐ b. Contamination is **NOT** consistent with background levels.

☐ **6. Class B-2 RAO**: You **MUST** provide an implemented AUL.

☐ **7. Class B-3 RAO**: You **MUST** provide an implemented AUL and justification that reducing contamination to less than Upper Concentration Limits (UCLs) 15 feet below ground surface is infeasible.

☐ **8. Class C-1 RAO**: You must submit a plan as specified at 310 CMR 40.0861(2)(h). Indicate type of ongoing response actions.

☐ a. Active Remedial System ☐ b. Active Remedial Monitoring Program ☐ c. None

☐ d. Other Specify: ______

☐ **9. Class C-2 RAO**: You must hold a valid Tier I Permit or Tier II Classification to continue response actions toward a Permanent Solution.

F. RESPONSE ACTION OUTCOME INFORMATION:

1. Specify the Risk Characterization Method(s) used to achieve the RAO described above:

☐ a. Method 1 ☐ b. Method 2 ☑ c. Method 3

☐ d. Method Not Applicable-Contamination reduced to or consistent with background, or Threat of Release abated

2. Specify all Soil Category(ies) applicable. More than one Soil Category may apply at a Site. Be sure to check off all **APPLICABLE** categories:

☐ a. S-1/GW-1 ☐ d. S-2/GW-1 ☐ g. S-3/GW-1

☑ b. S-1/GW-2 ☑ e. S-2/GW-2 ☐ h. S-3/GW-2

☑ c. S-1/GW-3 ☑ f. S-2/GW-3 ☑ i. S-3/GW-3

3. Specify all Groundwater Category(ies) impacted. A site may impact more than one Groundwater Category. Be sure to check off all **IMPACTED** categories:

☐ a. GW-1 ☐ b. GW-2 ☑ c. GW-3 ☐ d. No Groundwater Impacted

4. Specify remediation conducted:

☑ a. Check here if soil remediation was conducted.

☑ b. Check here if groundwater remediation was conducted.

5. Specify whether the analytical data used to support the Response Action Outcome was generated pursuant to the Department's Compendium of Analytical Methods (CAM) and 310 CMR 40.1056:

☐ a. CAM used to support all analytical data. ☑ b. CAM used to support some of the analytical data.

☐ c. CAM not used.

☑ 6. Check here to certify that the Class A, B or C Response Action Outcome includes a Data Usability Assessment and Data Representativeness Evaluation pursuant to 310 CMR 40.1056.

7. Estimate the number of acres this RAO Statement applies to: **10.6**

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC104

RESPONSE ACTION OUTCOME (RAO) STATEMENT

Pursuant to 310 CMR 40.1000 (Subpart J)

Release Tracking Number: 3 - 208

G. LSP SIGNATURE AND STAMP:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and 309 CMR4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> *if Section B indicates that either an* ***RAO Statement, Phase I Completion Statement and/or Periodic Review Opinion*** *is being provided,* the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal.

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

1. LSP #: **9415**

2. First Name: **JOHN D** 3. Last Name: **RENDALL**

4. Telephone: **(617) 523-2260** 5. Ext.: 6. FAX:

7. Signature:

8. Date: mm/dd/yyyy

9. LSP Stamp:

H. PERSON MAKING SUBMITTAL:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☐ c. change in the person undertaking response actions

2. Name of Organization: **REICHHOLD INC**

3. Contact First Name: **JOHN** 4. Last Name: **OLDHAM**

5. Street: **PO BOX 13582** 6. Title: **PROJECT MGR**

7. City/Town: **RESEARCH TRIANGLE PARK** 8. State: **NC** 9. ZIP Code: **277093582**

10. Telephone: **(919) 990-7789** 11. Ext.: 12. FAX:

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

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RESPONSE ACTION OUTCOME (RAO) STATEMENT

Pursuant to 310 CMR 40.1000 (Subpart J)

Release Tracking Number

3 - 208

I. RELATIONSHIP TO RELEASE OR THREAT OF RELEASE OF PERSON MAKING SUBMITTAL:

- [x] 1. RP or PRP
  - [x] a. Owner
  - [ ] b. Operator
  - [ ] c. Generator
  - [ ] d. Transporter
  - [ ] e. Other RP or PRP Specify:
- [ ] 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)
- [ ] 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))
- [ ] 4. Any Other Person Making Submittal Specify Relationship:

J. REQUIRED ATTACHMENT AND SUBMITTALS:

- [ ] 1. Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.
- [ ] 2. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of an RAO Statement that relies on the public way/rail right-of-way exemption from the requirements of an AUL.
- [x] 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of a RAO Statement with instructions on how to obtain a full copy of the report.
- [x] 4. Check here to certify that documentation is attached specifying the location of the Site, or the location and boundaries of the Disposal Site subject to this RAO Statement. If submitting an RAO Statement for a PORTION of a Disposal Site, you must document the location and boundaries for both the portion subject to this submittal and, to the extent defined, the entire Disposal Site.
- [x] 5. Check here to certify that, pursuant to 310 CMR 40.1406, notice was provided to the owner(s) of each property within the disposal site boundaries, or notice was not required because the disposal site boundaries are limited to property owned by the party conducting response actions. (check all that apply)
  - [ ] a. Notice was provided prior to, or concurrent with the submittal of a Phase II Completion Statement to the Department.
  - [x] b. Notice was provided prior to, or concurrent with the submittal of this RAO Statement to the Department.
  - [ ] c. Notice not required.
  - d. Total number of property owners notified, if applicable: 2
- [x] 6. Check here if required to submit one or more AULs. You must submit an AUL Transmittal Form (BWSC113) and a copy of each implemented AUL related to this RAO Statement. Specify the type of AUL(s) below: (required for Class A-3, A-4, B-2, B-3 RAO Statements)
  - [x] a. Notice of Activity and Use Limitation
  - b. Number of Notices submitted: 1
  - [ ] c. Grant of Environmental Restriction
  - d. Number of Grants submitted:
- [ ] 7. If an RAO Compliance Fee is required for any of the RTNs listed on this transmittal form, check here to certify that an RAO Compliance Fee was submitted to DEP, P. O. Box 4062, Boston, MA 02211.
- [ ] 8. Check here if any non-updatable information provided on this form is incorrect, e.g. Site Address/Location Aid. Send corrections to the DEP Regional Office.
- [x] 9. Check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

Massachusetts Department of Environmental Protection

Bureau of Waste Site Cleanup

BWSC104

RESPONSE ACTION OUTCOME (RAO) STATEMENT

Pursuant to 310 CMR 40.1000 (Subpart J)

Release Tracking Number

3 - 208

K. CERTIFICATION OF PERSON MAKING SUBMITTAL:

1. I, ______, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

2. By: ______ Signature

3. Title: PROJECT MGR

4. For: REICHHOLD INC (Name of person or entity recorded in Section H)

5. Date: ______ mm/dd/yyyy

☐ 6. Check here if the address of the person providing certification is different from address recorded in Section H.

7. Street: ______

8. City/Town: ______ 9. State: ______ 10. ZIP Code: ______

11. Telephone: ______ 12. Ext.: ______ 13. FAX: ______

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO $10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. YOU MUST LEGIBLY COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

Date Stamp (DEP USE ONLY:)

Attachment B - Human Health Risk Assessment Addendum - Former Manufacturing Area and Shawsheen River

Report

Human Health Risk Assessment Addendum and Safety and Public Welfare Risk Characterization – Former Manufacturing Area and Shawsheen River (RTN 3-0208)

Prepared for

Reichhold, Inc

November 2012

CH2MHILL

25 New Chardon St. Suite 500
Boston, MA 02114

Contents

Acronyms

ADD	Average Daily Dose
ADE	Average Daily Exposure
AUL	Activity and Use Limitation
BAF	Biological Accumulation Factor
BSAF	Biota-Sediment Accumulation Factor
BTL	BTL Specialty Resins
BWSC	Bureau of Waste Site Clean-up
CMR	Code of Massachusetts Regulations
COC	Contaminant of Concern
CSA	Comprehensive Site Assessment
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
EBA	Equalization Basin Area
ELCR	Excess Lifetime Cancer Risk
EPC	Exposure Point Concentration
FI	Final Inspection
FMA	Former Manufacturing Area
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HHRAA	Human Health Risk Assessment Addendum
HI	Hazard Index
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System
JEM	Johnson and Ettinger Model
ISCO	in-situ chemical oxidation
IWPA	Interim Wellhead Protection Area
K_{ow}	Octanol-Water Partition Coefficient
LFA	Landfill Area
MADEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
MMCL	Massachusetts Maximum Concentration Level
MNA	Monitored Natural Attenuation
MTBE	Methyl tertiary butyl ether
NPDWSA	Non-Potential Drinking Water Source Area
OMM	Operations, Maintenance, and Monitoring
ORC	Oxygen Release Compound
PAH	Polycyclic Aromatic Hydrocarbon
PPA	Potentially Productive Aquifer

PPRTV	Provisional Peer Reviewed Toxicity Values
RAO	Response Action Outcome
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
SVOC	Semi-volatile Organic Compound
TMB	Trimethylbenzene
UCL	Upper Concentration Limit
URF	Unit Risk Factor
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
$\mu g/m^3$	microgram per cubic meter
$\mu g/L$	microgram per liter
mg/m^3	milligram per cubic meter
lbs	pounds

Human Health Risk Assessment Addendum and Safety and Public Welfare Risk Characterization

1 Introduction

This Human Health Risk Assessment Addendum (HHRAA) is an update of the 1997 Human Health Risk Assessment (HHRA) that was prepared for the former Reichhold, Inc. (Reichhold) facility, located in Andover, Massachusetts (RTN 3-0208). The 1997 HHRA evaluated current and/or future risk at the former manufacturing, equalization basin, and landfill areas of the site prior to implementation of various remedial actions.

The objective of this HHRAA is to evaluate the potential current and future site risks subsequent to remedial actions implemented at the former manufacturing area (FMA) since 1997. The HHRAA evaluated potential exposures based on current land use and two reasonably foreseeable future use scenarios: commercial/industrial and recreational. Additionally, potential current and future risks were estimated for recreational exposures in the Shawsheen River reach adjacent to the site. The lower Shawsheen River transects the Reichhold Site and borders the FMA. There are currently no restrictions to recreational access on the Shawsheen River within the vicinity of the Reichhold facility. Some of the potential recreational activities on the lower Shawsheen River include wading, boating and fishing.

The exposure pathways evaluated and the methods used to update the 1997 HHRA are in compliance with the most recent MADEP protocols developed for preparing Method 3 Risk Characterizations, including the *Interim Final Vapor Intrusion Guidance* (MADEP, 2011), *Massachusetts Contingency Plan (MCP) Subpart I – Risk Characterization* (310 CMR 40.0900), and *Guidance for Disposal Site Risk Characterization* (MADEP, 1995).

The former equalization basin area (EBA) and former landfill area (LFA) are addressed in separate risk assessments. A Class A-3 Partial Response Action Outcome (RAO) Statement was filed in 2004 for the non-wetland portion of the former EBA (*Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel II [non-wetland portion]* (CH2M HILL, December, 2004). A Class A-3 partial RAO was electronically filed for the wetland portion of the former EBA in March 2009. A *Class A-3 Permanent Solution Partial Response Action Outcome Statement - Parcel I Former Landfill Area* (CH2M HILL, 2004) was originally filed in December 2004. Technical/compliance screening audit comments were received from MADEP, dated November 6, 2005. The document was revised to address MADEP comments and on August 5, 2008, a revised *Documentation Supporting a Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel I Former Landfill Area* (CH2M HILL, July 2008) was electronically filed with the MADEP Bureau of Waste Site Clean-Up (BWSC). A document entitled *Revised Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel I Former*

Landfill Area was electronically filed in April, 2009 (CH2M HILL, April, 2009). This risk assessment is being prepared to support a Partial RAO for the FMA portion of the former Reichhold property. This is the final Partial RAO in a series covering the former Reichhold property.

2 Background and Methods

Site History

The site is located in an area zoned for industrial/commercial and residential use. The FMA is zoned Industrial A, which permits most industrial and office uses. The land was used for industrial operations between the 1930's and 1990. Reichhold purchased the property in 1953 and manufactured phenolic, urea formaldehyde, and other resins. BTL Specialty Resins (BTL) purchased the property in 1986 and continued to manufacture resins until 1990 when the facility was closed. The facility has not been in operation since February 1990. An 8-foot tall chain link fence topped with barbed wire surrounds the FMA on all sides. Section 3 of the FMA Response Action Outcome Statement, to which this HHRAA is attached, provides a summary of response actions involving soils removal/disposal, building demolition, and soils and groundwater treatment involving ORC®, EHC®, and ISCO (sodium persulfate) that occurred between 1998 and 2006. Monitoring has continued on a biannual basis since 2006 to continue to document enhanced intrinsic bioremediation following completion of application the referenced remedial additives in 2006.

Approaches and Methods

The overall approach used in this HHRAA is consistent with 310 Code of Massachusetts Regulations (CMR) Section 40 of the *Massachusetts Contingency Plan (*February 2008) and the *Guidance for Disposal Site Characterization* (MADEP, 1995)**.** As stated in the MCP, there are three basic approaches for risk characterization: a chemical-specific method where site soil and groundwater chemical concentrations are compared with corresponding published standards (referred to as Method 1); a cumulative risk approach where site-specific information is incorporated into the risk estimates and compared with the MADEP cancer and non-cancer risk limits (Method 3); and a hybrid approach that allows development of some site-specific and chemical-specific data to supplement Method 1 Standards (Method 2).

A Method 3 approach was selected to evaluate the potential risks posed by the post-remediation residual concentrations at the FMA and potential risks from exposures in the Shawsheen River (within the vicinity of the site). This Method 3 HHRAA incorporates site-specific conditions and therefore, provides a more meaningful basis for evaluating the significance of potential risks posed to current and reasonably foreseeable future receptors by residual concentrations remaining at the FMA rather than a simple comparison of site data to published standards. The intake and risk estimates are presented in **Appendices A, B, and C**.

Groundwater Categories

The area of the FMA is within a potentially productive aquifer (PPA) but has been classified as a non-potential drinking water source area (NPDWSA) by MassGIS, in accordance with 310 CMR 40.006 and *Determining Non-Potential Drinking Water Source Areas Policy,* WSC-97-701, (MADEP, 1997), due to past use and development in the area. The policy states the following:

> *NPDWSAs include land that has been developed for specific urbanized uses and/or is so densely populated that installation of a new public water supply there is highly unlikely. NPDWSAs are not considered to be potential drinking water source areas. Therefore, groundwater cleanups in these areas do not need to meet Massachusetts Drinking Water Standards (provided other GW-1 criteria defining Current or Potential Drinking Water Source Areas do not apply).*

The area does not fit the MCP definitions in 310 CMR 40.0006 of a "current" (i.e., within Zone II, Interim Wellhead Protection Area (IWPA), Zone A of Class A surface water body, or 500 feet of a private well) or "potential" (i.e., greater than 500 feet from a municipal supply or within a municipal groundwater protection district) drinking water source areas. Consequently, GW-1 does not apply. Groundwater category GW-3, protective of surface water, is applicable for all groundwater across the site since it may discharge to surface water. GW-2, protective of indoor air, is applicable within 30 feet of existing or planned buildings anywhere on the site, since the average annual depth of groundwater across the site is 15 feet or less (310CMR.0932(6)). Figure 1 provides a Priority Resource Map available online from MassGIS depicting the extent of the NPDWSA beneath the property.

Soil Categories

The MADEP classifies soils at a site into categories S-1, S-2, and S-3 based on exposure potential (i.e., receptor type, frequency of use, intensity of use, and accessibility). Category S-1 is associated with the highest exposure potential, while S-3 is associated with the lowest exposure potential.

Portions of the FMA are currently leased by a crane and rigging company for equipment storage and lay-down. Workers and a site security guard may be present on an intermittent basis. Therefore, FMA site soils are considered category S-2 (adult receptors present, low-to-high frequency, low intensity of use, and accessible). Under potential future light industrial/commercial site use, FMA soils are considered category S-2 (adult receptors present, high frequency, low intensity exposure, and accessible). Under potential future recreational use, site soils in the FMA are considered category S-1 (potential child receptors present, high frequency, high intensity exposure, and accessible).

Surface Water Categories

Under the Massachusetts Surface Water Quality Standards (314 CMR 4.00), the lower Shawsheen River is classified as a Class B waterway. Class B waters are designated for primary and secondary contact recreation and should have consistently good aesthetic value.

Conceptual Site Model

The conceptual site model (CSM) qualitatively defines exposure pathways, exposure media, and potential receptors at the site under potential current and future land use conditions. **Exhibit 1-1** presents a table depicting the CSM. Only exposure pathways that are considered to be potentially complete are included in the CSM.

3 Data Review and Hazard Identification

In this subsection, site analytical data are summarized and contaminants of concern (COCs) are identified for the FMA.

- **Soil** - Data evaluation was conducted on soil analytical data generated during test pit excavation and soil boring advancement as part of the Phase II Comprehensive Site Assessment (CSA) and confirmatory sampling associated with the Phase IV Final Inspection (FI) conducted in 1997 and 1998, as well as post-remediation soil data collected in 2006, 2007, and 2008.
- **Concrete -** Concrete from the FMA was processed for use as surficial fill across the site. Composite samples of demolished concrete stockpiled onsite were collected in 2007 and 2008, and were used in the HHRAA.
- **Groundwater** - For the seven monitoring wells (CHMW-12, CHMW-13, GM-2, GM-6S, GP-06, GP-10, and GP-11) included in the Operations, Maintenance, and Monitoring (OMM) program, recent groundwater data collected during the last three years (2009, 2010, 2011) were included in the dataset. For the other wells, data from the two most recent years (2006 and 2007) were used.
- **Surface Water & Sediment** - Surface water and sediment samples collected from the lower Shawsheen River in July 2007 were used in the HHRAA.

Detailed descriptions of sampling methods and data analytical reports for the data used in this HHRAA can be found in the following sources:

- Phase II – CSA (CH2M HILL, 1997);
- Phase IV – Final Inspection Report (CH2M HILL, 1999) and Addenda (CH2M HILL, 2005, 2007, and 2008c);
- Post-RAO Operations, Maintenance, and Monitoring Report (CH2M HILL, 2007, 2008a, 2008b, 2008d, 2009a, 2009b, 2010, 2011a, and 2011b)

The data usage and sample assignments for each data grouping are summarized in **Exhibit D-1 in Appendix D**. The detected chemicals in soil, concrete, groundwater, sediment, and surface water samples, as well as a summary of the COC screening process, are presented in **Exhibits 2-1 through 2-10**.

Soil Contaminants of Concern

The analyte list used during the site characterization and remediation activities is the starting point for selecting the COCs. Analytical data were screened using the MADEP's

methodology for selecting COCs (MADEP, 1995). An analyte can be removed from further consideration if:

1. The analyte is not detected above the analytical detection limit in any sample collected at the area.
2. The analyte is present at low concentrations (relative to the method detection limit) and at a low frequency of detection.
3. The analyte is present at levels consistent with background and there is no evidence that the analyte was associated with site-related activities.
4. The analyte can be attributed to field or laboratory contamination.

The above criteria were used to screen and select the soil COCs for the exposure assessment. Analytes that were not detected in any of the soil samples were eliminated as COCs. COCs with a low frequency of detection and low concentration were retained in the HHRAA as an element of conservatism.

Soil samples collected from two depth intervals anywhere within the FMA and one depth interval within utility corridors were used to evaluate potential exposures as follows:

- the 0-2 ft interval anywhere within the FMA for evaluating potential risks to current industrial workers and future recreators (due to the low number of soil samples available from the 0-2 ft interval, soil data from the 0-4 ft interval were included in the dataset to characterize potential exposures to receptors for the 0-2 ft interval);

- the 0-6 ft interval anywhere within the FMA for evaluating potential risks to future industrial workers and future construction workers; and

- the 0-6 ft interval along the existing utility corridor only for evaluating potential risks to current/future utility workers.

The COC screening process for soil (0-2 ft bgs) is presented in **Exhibit 2-1**. For metals and polycyclic aromatic hydrocarbons (PAHs), the maximum detected soil concentrations were compared to background values published by MADEP (2002a). The maximum detected concentrations were below the MADEP background levels for nine analytes: arsenic, chromium, lead, mercury, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene. Therefore, these nine analytes detected in soil at the FMA were not retained as COCs in the exposure assessment. The following analytes were retained as COCs:

- 18 organic compounds including 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene,acetone, ethlybenzene, isopropylbenzene, n-butylbenzene, n-propylbenzene, naphthalene, methyl tert butyl ether (MTBE), methylene chloride, o-xylene, p-isopropyltoluene, p/m-xylene, total xylene, 2,4-dimethylphenol, 2-methylphenol/4-methylphenol, phenol, and bis[2-ethylhexyl]phthalate); and

- 6 metals including barium, cadmium, copper, iron, silver, zinc.

The COC screening process for soil (0-6 ft bgs) at the FMA is presented in **Exhibit 2-2.** The maximum detected concentrations were below the MADEP background levels for 13 analytes: mercury, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, and pyrene. Therefore, these 13 analytes detected in soil (0-6 ft bgs) at the FMA were not retained as COCs in the exposure assessment. The following analytes were retained as COCs:

- 31 organic compounds including 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, 1,3,5-trimethylbenzene, 1,4-dichlorobenzene, 2-butanone, 4-methyl-2-pentanone, acetone, benzene, carbon disulfide, chlorobenzene, ethylbenzene, isopropylbenzene, n-butylbenzene, n-propylbenzene, naphthalene, MTBE, methylene chloride, o-xylene, p-isopropyltoluene, p/m-xylene, sec-butylbenzene, styrene, toluene, total xylenes, 2,4-dimethylphenol, 3-methylphenol/4-methylphenol, phenol, 2-methylnaphthalene, bis[2-ethylhexyl]phthalate, dibenzofuran, and phenanthrene; and
- 9 metals including arsenic, barium, cadmium, chromium, copper, iron, silver, zinc.

The COC screening process for soil (0-6 ft bgs) only along the utility corridor at the FMA is presented in **Exhibit 2-3**. The maximum detected concentrations exceeded the MADEP background levels for all analytes. Therefore, all analytes detected in soil (0-6 ft bgs) along the utility corridor at the FMA were retained as COCs. The following analytes were retained as COCs:

- 16 VOCs including 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1,4-dichlorobenzene, 2-butanone, acetone, carbon disulfide, chlorobenzene, ethylbenzene, n-propylbenzene, naphthalene, o-xylene, p/m-xylene, total xylenes, 2,4-dimethylphenol, 3-methylphenol/4-methylphenol, phenol; and
- 2 metals including cadmium, and zinc.

Demolished Concrete Contaminants of Concern

Because demolished concrete was processed for use as future surficial fill across the site, data are used in an evaluation of potential surface exposures to future industrial workers, utility workers, construction workers, and recreational uses. Therefore, the screening process for identifying demolished concrete COCs was conducted in the same manner as previously described for soil.

Analytical data from the concrete samples were previously evaluated and compared to Method 1 Category S-1 standards in the 2007 Post-RAO OMM Reports (CH2M HILL, 2008a,b); the concentrations were less than Method 1 S-1 standards and the concrete was concluded to be suitable for reuse as fill material. However, based on its future use as onsite fill material to be co-mingled with soil, a conservative approach was used and the demolished concrete material was evaluated in the same manner as soil in the HHRA.

The COC screening process for demolished concrete is presented in **Exhibit 2-4**. For metals and PAHs, the maximum detected concrete concentrations were compared to background soil values published by MADEP (2002a). The maximum detected concentrations of five analytes were below the MADEP soil background levels for fluoranthene, arsenic, chromium (VI), lead, and mercury. Therefore, these five analytes detected in demolished concrete at the FMA were not retained as COCs in the exposure assessment. The following analytes were retained as COCs:

- 2 VOCs including acetone and p/m-xylene;
- 1 SVOC (phenol);
- 7 metals including barium, cadmium, total chromium, chromium III, copper, iron, and zinc; and
- 1 TPH fraction (C19-C36 Aliphatics).

Groundwater Contaminants of Concern

The screening process for groundwater COCs was conducted in the same manner as previously described for soil. Analytes were screened against the groundwater background levels included in MADEP's Numerical Standards Spreadsheets (MADEP, 2009).

Three groundwater data groupings were used to evaluate potential groundwater exposures:

- All areas of the FMA, based on all groundwater samples in the dataset (for evaluating future industrial workers [indoor air] and future construction workers [direct contact]);
- Groundwater adjacent to (immediately upgradient and immediately downgradient) the existing office and warehouse only, based on samples collected in May 2007 (for evaluating potential indoor air exposures to current industrial workers and future recreational users); and
- Groundwater in the utility corridor only, based on samples collected in December 2006 and May 2007 (for evaluating direct contact exposures by current/future utility workers).

The COC screening process for groundwater in all areas of the FMA is presented in **Exhibit 2-5**. The maximum detected concentrations of cadmium, chromium, and mercury were below the MADEP groundwater background levels and were not retained as COCs in the exposure assessment. The following analytes were retained as COCs:

- 37 organic compounds including 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, 1,2-dichloroethane, 1,3,5-trimethylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dichlorophenol, 2,4-dimethylphenol, 2-methylnaphthalene, 3-methylphenol/4-methylphenol, 4-methyl-2-pentanone, acetone, benzene,

benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, chlorobenzene, dibenzo[a,h]anthracene, ethylbenzene, fluorene, formaldehyde, indeno[1,2,3-cd]pyrene, isopropylbenzene, MTBE, naphthalene, n-butylbenzene, n-propylbenzene, o-xylene, p/m-xylene, phenanthrene, phenol, p-isopropyltoluene, sec-butylbenzene, styrene, tert-butylbenzene, tertiary-amyl methyl ether, toluene; and

- 5 metals including arsenic, barium, iron, manganese and zinc.

Exhibit 2-6 presents the COC screening process for groundwater near the existing office and warehouse at the FMA. No MADEP background levels were available for the analytes detected in this dataset. Only one VOC (MTBE) was detected in groundwater near the office and warehouse at the FMA. Although its maximum detected concentration was less than the MADEP GW-2 standard, MTBE was retained as a COC.

The COC screening process for groundwater along the existing utility corridor within the FMA is presented in **Exhibit 2-7**. The maximum detected concentrations were below the MADEP background levels for cadmium, chromium, and mercury. Therefore, these three analytes detected in groundwater along the utility corridor were not retained as COCs in the exposure assessment. The following analytes were retained as COCs:

- 28 organic compounds including 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, 1,3,5-trimethylbenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 4-methyl-2-pentanone, acetone, benzene, chlorobenzene, ethylbenzene, isopropylbenzene, MTBE, n-butylbenzene, n-propylbenzene, naphthalene, o-xylene, p-isopropyltoluene, p/m-xylene, toluene, 2,4-dimethylphenol, 2-methylnapthalene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene phenol; and
- 4 metals including arsenic, barium, iron, and zinc.

Sediment Contaminants of Concern

The screening process for sediments in the Shawsheen River was conducted in a similar manner as described for soil and groundwater. Detected concentrations were screened against upstream concentrations and were not retained as COCs if the maximum detected concentration was less than the upstream concentration and there was no evidence relating the analyte to historic site activities. Additionally, chemicals that were not considered bioaccumulative were eliminated as COCs for the fish ingestion pathway.

Organic chemicals were considered bioaccumulative if their log octanol-water partition coefficient (K_{ow}) exceeded three, with the exception of fluoranthene. Fluoranthene was not identified as a COC because PAHs are readily metabolized by fish and are not expected to bioaccumulate in fish tissue or biomagnify in the food chain (ATSDR, 1995; MADEP, 1995). Inorganic chemicals were identified as bioaccumulative based on USEPA's (2000) *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment - Status and Needs*.

The COC screening process for sediment is presented in **Exhibits 2-8** and **2-9** for the direct exposure and fish ingestion pathways, respectively. The maximum detected concentrations were below the upstream concentrations for arsenic and iron. Therefore,

arsenic and iron were not retained as COCs in sediment in the exposure assessment. The following analytes were retained as COCs in sediment for the direct exposure pathways:

- 11 organic compounds including 1,2,4-trimethylbenzene, 2-butanone, acetone, carbon disulfide, chlorobenzene, ethyl ether, ethylbenzene, isopropylbenzene, o-xylene, p/m-xylene, fluoranthene; and
- 7 metals including barium, cadmium, chromium, copper, lead, mercury, and zinc.

The following analytes were retained as COCs in sediment for the fish ingestion pathway:

- 5 organic compounds including 1,2,4-trimethylbenzene, ethylbenzene, isopropylbenzene, o-xylene, p/m-xylene; and
- 6 metals including cadmium, chromium, copper, lead, mercury, and zinc.

Surface Water Contaminants of Concern

The COC screening process for surface water in the Shawsheen River is presented in **Exhibit 2-10**. The screening process for surface water was conducted in the same manner as previously described for sediment. Only one analyte, p/m-xylene, was detected in surface water. The maximum detected concentration of p/m-xylene exceeded the upstream concentration. Therefore, p/m-xylene was retained as a COC for surface water in the exposure assessment.

Applicable Standards or Criteria

In this HHRAA, cumulative cancer and non-cancer risks potentially related to residual site contaminants were estimated. The residual risks were compared with the MCP cumulative risk limits (310 CMR 40.902(2)(b)): an excess lifetime cancer risk (ELCR) of 1E-05 (one case of cancer in a population of 100,000) and a hazard index (HI) of 1 for non-cancer effects . Additionally, exposure point concentrations (EPCs) were compared to upper concentration limits (UCLs) in groundwater and soil. As stated in Subpart I of the 2008 MCP (310 CMR 40.0993 (7)), "a condition of no significant risk of harm to human health exists or has been achieved if:

1. No EPC of oil and/or hazardous material is greater than an applicable or suitably analogous public health standard;
2. No Cumulative Receptor Cancer risk calculated is greater than the Cumulative Risk Limit; and
3. No Cumulative Receptor Non-cancer risk is greater than the Cumulative Receptor Non-cancer Risk limit."

These criteria were used in the HHRAA to assess whether a significant risk to human health may exist at the FMA and Shawsheen River.

4 Dose-Response Assessment

Potential adverse health effects associated with the COCs are described and the toxicity data are summarized in this section. The toxicity data are used in Section 6 in conjunction with exposure intakes to characterize potential risks to receptors.

Cancer and Non-cancer Effects and Indices

The purpose of the dose-response or toxicity assessment is to provide an estimate of the relationship between the extent of exposure and the increased likelihood of adverse effects. Toxic responses are broadly classified as non-threshold (cancer) effects and threshold (non-cancer) effects. The principal indices of toxicity are cancer slope factor (CSF) or unit risk factor (URF), and reference dose (RfD) or reference concentration (RfC).

For dose-response assessment of carcinogens, the United States Environmental Protection Agency (USEPA) assumes a zero-threshold (i.e., there is no dose that produces zero risk). The CSF is a measure of the ability of a chemical to increase the incidence of cancer in exposed populations. A related measure is URF (i.e., incremental cancer risk estimated to result from intake of air at a concentration of 1 $\mu g/m^3$ [microgram per cubic meter] or water at 1 $\mu g/L$ [microgram per liter]). These measures represent upper-bound (conservative) estimates derived from linearized multistage models with the highest possible linear slopes in the 95% confidence limit.

A second important consideration in evaluating carcinogens is the weight-of-evidence classification. This classification is based on available animal, human, and other supportive data that suggest the likelihood that the substance is a human carcinogen. The USEPA classification is similar, but not identical, to that of the International Agency for Research on Cancer (IARC). These classifications are currently under review, but Group A and Group B substances have been considered probable human or animal carcinogens. The MADEP cumulative cancer risk limit for Group A and B carcinogens is one incremental cancer case in a population of 100,000, expressed as 1E-05 or 1×10^{-5}.

For non-cancer effects, it is assumed that a level of exposure or dose exists below which no adverse health effects would be expected for the general population, including sensitive subgroups (e.g., children). Such a threshold, identified by dose-response studies, is represented by the RfD for a chemical. This is the average daily dose (ADD) or intake of the chemical per unit body weight per day (mg/kg-day). The projected dose of COCs via relevant exposure pathways are combined to derive a HI. The MADEP non-cancer cumulative risk limit is a HI of 1 for a specific target organ or critical effect.

RfDs are generally applicable to oral and dermal exposures. Similarly, for inhalation exposures, RfCs (in mg/m^3 [milligram per cubic meter]) have been developed for some chemicals. Because the local effects on the respiratory system and absorption factors may be different for inhalation exposures, conversion of RfC to RfD and vice-versa is not generally recommended.

Toxicity Data for Contaminants of Concern

The principal sources of toxicity data used in this HHRAA are listed below in order of preference:

- MADEP's Numerical Standards Spreadsheets (MADEP, 2009);
- Integrated Risk Information System (IRIS) – USEPA's on-line database (USEPA, 2012a);
- Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by USEPA's Superfund Health Risk Technical Support Center (STSC) for the USEPA Superfund program; and
- Health Effects Assessment Summary Tables (HEAST) - USEPA's hard-copy version containing provisional toxicity values (USEPA, 1997).

Toxicity data, as well as relative absorption factors for the COCs, are summarized in **Exhibits 3-1 through 3-4**. MADEP's Numerical Standards Spreadsheets were used as the primary toxicity data source. When a chemical had more recent quantitative toxicity values available from USEPA IRIS or PPRTVs, their values were used. The IRIS toxicity values and PPRTVs were obtained from the USEPA's Regional Screening Level Table (USEPA, 2012b) and the IRIS values were verified with the original online source (http://www.epa.gov/iris).

5 Exposure Assessment

Potential exposures to site media were evaluated based on current and anticipated future land use for the FMA and the Shawsheen River.

Exposure Pathways

Exposure is contact with, or access to, a contaminant. An exposure pathway is the pathway for contaminants from the source to a receptor via environmental media, generally air (volatile compounds, airborne particulates), water (soluble compounds), or soil. An exposure route denotes how the transfer occurs (i.e., by inhalation, ingestion, or dermal contact). An environmental risk may exist only when there is a complete pathway.

For an exposure pathway to be complete now or in the future, it must consist of five elements: (1) a source, (2) a release mechanism, (3) a transport medium for released constituents, (4) a point of contact with contaminated media, and (5) intake or uptake routes at the point of contact by a receptor. Without all these elements, an exposure pathway is considered incomplete and, therefore, would not contribute to risk by that particular pathway.

When evaluating potential exposure pathways, current and future land use, site sources, exposure pathways, and potential receptors were considered. Complete exposure pathways are summarized in the CSM in **Exhibit 1-1**. Exposure factors and assumptions are presented in **Exhibit 4-1**. These two exhibits provide the potential exposure profiles based on a combination of site-specific data and the MADEP default exposure factors.

This information is used for quantifying potential exposures at the FMA and Shawsheen River.

The FMA is zoned Industrial A, which allows most industrial and office uses. A current industrial scenario and future industrial and recreational scenarios were evaluated for the FMA. These scenarios are further described as follows:

- **Current industrial workers** – Portions of the FMA are currently leased as a laydown area for construction equipment, and workers and a site security guard may be present on an intermittent basis. Although these workers are not involved in invasive soil activities at the site, current workers may occasionally be exposed to surface soil (ingestion, inhalation of outdoor dust and volatiles, and dermal contact) and indoor air at existing buildings (inhalation of volatile constituents that have migrated from groundwater to indoor air);
- **Future industrial workers** – If the site is developed as an industrial facility in the future, industrial workers may be exposed to soil (ingestion, inhalation of outdoor dust and volatiles, and dermal contact), demolished concrete (ingestion, inhalation of dust and volatiles, and dermal contact), and indoor air at a building that may be constructed anywhere on-site (inhalation of volatile constituents that have migrated from groundwater to indoor air);
- **Future recreational users (adult and youth [7 to 18 years of age])** - If the site is developed for recreational use in the future, recreational users may be exposed to soil (ingestion, inhalation of outdoor dust and volatiles, and dermal contact), demolished concrete (ingestion, inhalation of outdoor dust and volatiles, and dermal contact), and indoor air at future buildings constructed anywhere on-site (inhalation of volatile constituents that have migrated from groundwater to indoor air);
- **Future construction workers** – During future site redevelopment, construction workers may be exposed to soil (ingestion, inhalation of outdoor dust and volatiles, ingestion of inhaled dust, and dermal contact), demolished concrete (ingestion, inhalation of outdoor dust and volatiles, and dermal contact), and groundwater (inhalation of volatile constituents and dermal contact during excavation activities) anywhere on-site.
- **Current utility workers** – During emergency repairs to utilities in the existing utility corridor, current utility workers may be exposed to soil (ingestion, inhalation of outdoor dust and volatiles, ingestion of inhaled dust, and dermal contact) and groundwater (inhalation of volatile constituents and dermal contact during excavation activities) in the existing utility corridor.
- **Future utility workers** – During emergency repairs to utilities in the existing utility corridor, future utility workers may be exposed to soil and demolished concrete (ingestion, inhalation of outdoor dust and volatiles, ingestion of inhaled dust, and dermal contact), and groundwater (inhalation of volatile constituents and dermal contact during excavation activities) in the existing utility corridor.

The current/future exposure pathways that were quantified for a recreational user (adult and youth **[7 to 18 years of age]**) at the lower Shawsheen River consist of

ingestion and dermal contact with surface water, dermal contact with sediment, and ingestion of fish.

Exposure Quantification

This step involves estimation of EPCs for COCs and calculation of exposure (or dose). The quantification of potential exposure (dose) involves equations with three sets of variables: (1) chemical concentrations in environmental media of interest – soil, concrete, groundwater, surface water, sediment, air (ambient and indoor), and fish; (2) exposure rates (magnitude, frequency, and duration); and (3) biological characteristics of receptors (body weight, dermal and gastrointestinal absorption, and life span).

Exposure Point Concentrations

EPCs are derived from measured, monitored, and/or modeled data. Ideally, exposure concentrations should be measured at the points of direct contact between the environmental media and receptors. It is possible to identify potential receptors and exposure points from field observations and other information. However, it is seldom possible to anticipate all potential exposure points now and in the future and measure environmental concentrations under all conditions. The EPCs used in the HHRAA are presented in **Exhibits 2-1** through **Exhibit 2-10**.

EPCs were determined using MADEP's methodology presented in Subpart I of the 2008 MCP (310 CMR 40.0926). As stated in the MCP (310 CMR 40.0926), "for chronic and subchronic exposures (other than for screening evaluations), the arithmetic average of site data is acceptable as an Exposure Point Concentration, provided either of the following criteria are met:

1. For discrete or composite samples, the arithmetic average is less than or equal to the applicable standard or risk-based concentration limit, 75% of the data points used in the averaging procedure are equal to or less than the applicable standard or risk-based concentration limit, and no data point used in the averaging is ten times greater than the applicable standard or risk-based concentration limit; or

2. A valid justification is provided indicating that the sample mean is unlikely to substantially underestimate the true mean of the concentration of oil or hazardous material at the Exposure Point. Such a demonstration should include, but need not be limited to, consideration of the observed distribution of the data, sampling strategy (including frequency, density, and potential biases), graphical representation of analytical results, and/or statistical analyses."

Proxy substitution of ½ the reporting limit was made for non-detected concentrations when calculating the arithmetic average. For the concrete data, reporting limits were not provided by the laboratory so only the detected concentrations were used to calculate the arithmetic average. The data groups used in the HHRAA meet the criterion #1 (**Exhibit D-2 through D-5 in Appendix D**); therefore, arithmetic average concentrations of COCs were used in the exposure estimation. With the exception of the indoor air

pathway, arithmetic averages of COCs were calculated for the data groupings and used as EPCs for the intake calculations and to model fish tissue concentrations and ambient air concentrations in an excavation. A simplifying assumption was made that EPCs at the site will remain constant over time; no allowance was made for dissipation, attenuation, or degradation.

As a conservative approach, the maximum detected concentrations in groundwater were used as input concentrations to the Johnson and Ettinger Model (JEM) to estimate current indoor air concentrations at the two existing buildings on-site. Future indoor air concentrations were estimated based on maximum detected concentrations in groundwater since a building may be constructed anywhere on-site in the future.

Soil

Three sets of EPCs were calculated for soil:

- the 0-2 ft interval anywhere within the FMA (for evaluating potential risk to current industrial workers and future recreators);
- the 0-6 ft interval anywhere within the FMA (for evaluating potential risk to future industrial workers and future construction workers); and
- the 0-6 ft interval along the existing utility corridor in the FMA (for evaluating potential risk to current/future utility workers).

Demolished Concrete

One set of EPCs was calculated for demolished concrete assuming that the processed concrete would be reused as surficial fill across the site and receptors could come in contact with this fill material.

Groundwater

Three sets of EPCs were calculated for groundwater:

- all areas of the FMA (for evaluating future industrial workers [indoor air], future recreational users [indoor air], and future construction workers [direct contact]);
- adjacent to the office and warehouse only (for evaluating indoor air exposures to current industrial workers); and
- the existing utility corridor only (for evaluating current/future direct contact exposures to utility workers).

The EPCs in ambient air resulting from volatilization of constituents in groundwater in an open excavation were calculated using a two-film volatilization model (USEPA, 1991). The model is used to estimate emissions from the groundwater surface based on an overall mass transfer coefficient that incorporates two resistances to mass transfer in series, the liquid-phase resistance and the gas-phase resistance. The model's default input values (USEPA, 1988) were used in conjunction with site-specific values to estimate EPCs in ambient air. The assumptions used in the model are presented in **Appendix A (Table A-2-14. Supplement A and Table A-4-14.Supplement A)**.

The EPCs for indoor air were modeled using the JEM, Version 3.1 (USEPA, 2004). The MADEP's default parameters (MADEP, 2006) for the JEM were used to model current indoor air concentrations, as recommended in the *Vapor Intrusion Guidance* (MADEP, 2011). The input parameters used in the model are presented in **Appendix C (Table C-4)**, and the model output is provided in **Table C-5**.

Surface Water and Sediment

Surface water and sediment EPCs were calculated using data collected from the Shawsheen River. The EPCs for fish ingestion were modeled using sediment concentrations because only one chemical was detected in surface water (p/m-xylene) and this chemical was also detected in sediment. Generally, biota-to-sediment accumulation factors (BSAFs) and sediment concentrations are preferred over the use of t surface water biological accumulation factors (BAFs) and surface water concentrations because the BSAF accounts for multi-pathway fish uptake of COCs from surface water, sediment, and food items and biomagnification and trophic transfer via the food chain.

The BSAFs used to model fish tissue concentrations for inorganic COCs were obtained from the Washington Department of Ecology (1995). BSAFs were not available for the organic COCs identified for the fish ingestion pathway; therefore, a default value of one was used as the BSAF for organic COCs. The BSAFs used for the fish tissue modeling and the estimated EPCs in fish tissue are presented in **Exhibit 2-9 Supplement**. The parameters used to derive fish EPCs in units of mg of chemical per kg of fish fillet on a wet weight basis included: a site-specific organic carbon content in river sediment (0.985 percent [%]), the USEPA's (2000) default value for fish lipid content (5%), and the USEPA's (1993) default value for percent moisture in fish fillets (75%).

Hot Spot Analysis

The presence of Hot Spots was evaluated for each exposure medium with the exception of demolished concrete because it was assumed that demolished concrete would be spread over the site (as fill material) rather than placed in a single area (**Exhibit D-6 through D-8 in Appendix D**). As presented in Subpart A of the 2008 MCP (310 CMR 40.0006 (a)), a Hot Spot is defined as;

> *(a) Discrete areas where the average concentration within the area is greater than ten but less than one hundred times the average concentration in the immediate surrounding area is a Hot Spot unless there is no evidence that the discrete area would be associated with greater exposure potential than the surrounding area. In all cases, a discrete area where the concentration of an oil or hazardous material is greater than one hundred times the concentration in the surrounding area shall be considered a Hot Spot. In no case shall concentrations of oil or hazardous material equal to or less than an applicable Method 1 standard be considered indicative of a Hot Spot.*

The maximum detected concentration of 16 COCs in soil (0-6 ft bgs) exceeds 10 times their respective average concentrations and Method 1 S-2/GW-2 standards but are less than 100 times the average concentrations. There is no evidence that the locations of these elevated concentrations would be associated with greater exposure potential than the surrounding area; therefore, these sampling locations were not identified as Hot Spots.

Equations for Quantifying Exposure and Dose

The general equation for calculating average daily exposure (ADE) or dose (ADD) is of the form:

$$ADD = \frac{\text{total quantity of contaminant contacted}}{\text{body weight * averaging period}}$$

The specific exposure factors and assumptions used for the receptors and exposure pathways at the site are presented in **Exhibit 4-1**. The equations used to calculate the ADE or ADD were obtained from Section 7.3.3 of the MADEP's *Guidance for Disposal Site Risk Characterization* (MADEP, 1995) and are included in **Tables A-1-1 to A-6-12 in Appendix A** for potential current and future receptors at the FMA and **Tables B-1-1 to B-2-8 in Appendix B** for potential current and future receptors at the Shawsheen River. Interim calculations for the exposure factors are provided in **Tables C-1 through C-3 in Appendix C**. The ADDs estimated in this HHRAA are likely to represent reasonable maximum exposure (RME), defined as the maximum exposure that is reasonably expected to occur at a site. Thus, the exposure estimates in the HHRAA will likely be biased toward overestimating rather than underestimating potential public health risks associated with site COCs.

6 Risk Characterization

In this step, the results of the hazard identification and toxicity and exposure assessments are integrated to arrive at quantitative estimates of risk. Risk characterization is the bridge between risk assessment and risk management. An important aspect of risk characterization is the identification of uncertainty, including key assumptions, underlying the risk estimates. The numerical risks, therefore, should not be viewed in isolation, but in the context of the conditions existing or likely to exist at the site.

Cancer Risk

The potential for the development of cancer is expressed in terms of ELCR. This is the incremental probability of an individual developing cancer over a lifetime from exposure to a potential carcinogen. Since cancer effects are assumed to exhibit no safe thresholds, the risk of cancer exists for all carcinogen exposure no matter how small the dose might be. For low doses typical of environmental exposures, cancer risks are estimated with the following linear equation:

For ingestion or dermal contact:

$$ELCR = ADD\ (mg/kg\text{-}day) \times CSF\ (mg/kg\text{-}day)^{-1}$$

For inhalation exposures:

$$ELCR = ADE\ (mg/m^3) \times URF\ (mg/m^3)^{-1}$$

An ELCR of one in 100,000 for Group A and B carcinogens is considered to be the upper limit of MADEP regulatory guidelines.

Non-Cancer Risk

The potential for non-cancer effects to occur is assessed by comparing estimated chemical doses with corresponding RfDs that are considered to be safe thresholds. The RfD or RfC is considered to be a safe threshold for the general population including sensitive subgroups. The Hazard Quotient (HQ) for a single COC or HI for multiple COCs and/or exposure pathways is estimated as follows:

For ingestion or dermal contact exposures:

$$HQ = \frac{ADD\ (mg/kg\text{-}day)}{RfD\ (mg/kg\text{-}day)}$$

For inhalation exposures:

$$HQ = \frac{ADE\ (mg/m^3)}{RfC\ (mg/m^3)}$$

Cumulative HI = $\sum$ HQs for different chemicals and exposure routes

A cumulative HI of 1 or less indicates that the receptor's exposure is within the acceptable limit and no adverse effects are likely to occur. Therefore, a HI of 1 or less indicates no significant risk of non-cancer health effects.

Risk Estimates and Comparisons

The potential ELCRs and non-cancer HIs associated with exposures to site COCs are summarized below. Detailed calculations are provided in **Appendices A and B** and a summary of the ELCRs and HIs is presented in **Exhibit 5-1** and indicated below. With the exception of the indoor air pathway under a future scenario, the risk and HI estimates are within the MCP limits of 1E-5 for ELCR (for Group A and B carcinogens) and HI of 1 for non-cancer effects, as discussed below:

- **Current industrial worker (**soil and indoor air) - ELCR = 4E-09 and HI = 0.006 for soil; HI = 0.000002 for indoor air.
- **Current utility worker (**soil and groundwater) - ELCR = 5E-11 and HI = 0.001 for soil; ELCR = 2E-9 and HI = 0.002 for groundwater.
- **Future utility worker (**soil, groundwater, and demolished concrete) - ELCR = 5E-11 and HI = 0.001 for soil; ELCR = 2E-9 and HI = 0.002 for groundwater; ELCR = 2E-12 and HI = 0.0004 for demolished concrete.
- **Current/future Shawsheen River recreational user (**sediment, surface water, and fish) – total HI = 0.2 (adult) and 0.3 (youth) for all media.

- **Future industrial worker (**soil; demolished concrete; indoor air) - ELCR = 1E-06 and HI = 0.03 for soil; ELCR = 7E-10 and HI = 0.006 for demolished concrete; ELCR = 9E-06 and HI = 13 for indoor air, primarily associated with 1,2,4-trimethylbenzene and m/p-xylene.
- **Future construction worker (**soil; demolished concrete; groundwater) - ELCR = 3E-07 and HI = 0.7; ELCR = 2E-07 and HI = 0.4 for concrete; ELCR = 5E-08 and HI = 0.1 for groundwater.
- **Future onsite recreational user (**soil; demolished concrete; indoor air) - ELCR = 9E-10 (adult) and 4E-10 (youth), and HI = 0.001 (adult) and 0.002 (youth) for soil; ELCR = 2E-10 (adult) and 6E-11 (youth), HI = 0.002 (adult) and 0.004 (youth) for concrete; ELCR = 9E-06 and HI = 13 for indoor air (risk estimates for future industrial workers were used to conservatively represent risks for future onsite recreational adults and youth).

Comparison to UCLs

All of the EPCs calculated for the COCs in groundwater and soil were below the MADEP's UCLs presented in the MCP Numerical Standards Spreadsheets (MADEP, 2009).

Uncertainty in Risk Estimates

Uncertainty is inherent in every step of risk assessment from hazard identification to risk characterization. Sources of uncertainty include natural variability of the contaminants within affected environmental media and human response to exposure, measurement accuracy, model validity, and level of understanding of the actual health effects that contaminants have on human receptor populations. To appreciate the limitations of the risk estimates, it is important to understand the nature and magnitude of uncertainty. Sources of uncertainty and their tendency to over- or under-estimate risks at the site are briefly described below.

Contaminant Identification

Chemical concentrations in soil and groundwater at the site have been derived from several rounds of sampling over a number of years, but environmental media concentrations tend to vary over time and space, often by orders of magnitude. In general, the samples were analyzed for VOCs and SVOCs, including phenolics associated with historic operations at the facility, extractable petroleum hydrocarbons, volatile petroleum hydrocarbons, and selected inorganics (selected due to their elevated concentrations). It is expected that the most significant site-related contaminants in soil, groundwater, surface water, and sediment at the site have been identified.

Toxicity Data

Toxicological dose-response data are derived primarily from laboratory animal experiments. In extrapolating animal data to predict effects in humans, various uncertainty and modifying factors (safety factors) are used to account for the differences between and within species (inter- and intra-species), exposure periods (acute or subchronic to chronic), and doses (high to low). The CSFs are upperbound 95%

confidence limits derived from linearized multi-stage models. Also, virtually complete inhalation and oral absorption and bioavailability are assumed from environmental matrices. These models and assumptions are likely to substantially overestimate risk.

For a few chemicals detected at the site, quantitative toxicity data are not available for specific exposure pathways. For example, 1,2,4-trimethylbenzene does not have a published RfD for the oral route. Exclusion of such chemicals from the quantitative risk assessment leads to an underestimation of site risk.

In this HHRAA, the MADEP numerical standard workbook (MADEP, 2009) was used as the primary toxicity information source, supplemented by the most recent toxicity information in USEPA IRIS and PPRTV. It is acknowledged that some VOCs have varying degrees of evidence for carcinogenicity in humans and other environmental regulatory agencies may consider them carcinogens. For instance, ethylbenzene is classified as Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer and California Environmental Protection Agency has identified a quantitative toxicity value for ethylbenzene, which is presented in the USEPA RSL table as a Tier III toxicity value, based on adequate evidence of a carcinogenic effect in test animals (rats and mice). Exclusion of these Tier III toxicity values from the quantitative risk estimates may lead to an underestimation of site risk.

Exposure Estimates

In this assessment, some exposure factors are based on site-specific observations while others are based on MADEP conservative default factors, which cumulatively may tend to overestimate potential exposures.

At present, there is no specific receptor population that is likely to be exposed over the long-term to site contaminants. Because the site is currently used as an equipment lay-down area and there is uncertainty regarding future occupants and their activities in specific areas of the FMA, average chemical concentrations detected in the environmental media are used directly as EPCs for current and future exposures. No allowance is made for dilution, biodegradation and natural attenuation over time. Since some of the contaminants identified at the site are low molecular weight organic compounds subject to biodegradation, the use of currently detected media concentrations as future EPCs is likely to overestimate future health risks.

Significant uncertainty exists in the modeled fish tissue concentrations and resulting risk estimates due to the available BSAFs used for estimating fish concentrations. The COC concentrations in fish tissue were modeled using sediment concentrations from the lower Shawsheen River and BSAFs obtained from the Washington Department of Ecology (1995). However, the extent of actual bioaccumulation is site-specific and depends on various factors (e.g., fish species, specific part of the fish, and organic carbon content of the sediment). Therefore, the literature-based BSAFs may not represent the site-specific bioaccumulation that occurs in fish from the lower Shawsheen River. BSAFs were not available for the organic COCs; therefore, a default value of one was used to model fish concentrations. The use of default and literature-based BSAF values may over- or underestimate actual COC concentrations in fish tissue and potential exposures.

Based on discussions with a potential purchaser of the property, the most likely future use of the FMA is recreational (i.e., soccer fields). It is expected that the recreational user exposure scenarios quantified in this HHRAA are conservative enough to represent various recreational scenarios. Risks were calculated for youths (ages 7-18) and adults using the site for 3 days per week during April through October for a period of 11 years. The risks quantified for youths are expected to be conservative enough to represent potential risks to younger children who may occasionally visit the site with their parents during recreational activities.

Risk Characterization

In accordance with the approach used by MADEP and USEPA, as a simplification, potential risks associated with multiple COCs, exposure pathways, and exposure routes are assumed to be additive. In reality, the effects of multiple chemical exposures could be additive, synergistic, or antagonistic. Baseline HHRAs typically address only site-related risks, while the public is exposed to multiple chemical, physical, and biological hazards via multiple pathways. Their interactive and cumulative effects are complex and extremely difficult to predict. In HHRA, there is an implicit assumption that, overall, they balance out, and that using a series of conservative assumptions about a known source comprise a prudent public health policy. For the reasons identified above, the site-related health risk estimates in this HHRAA are more likely to be overestimates, rather than underestimates, of site risk.

Indoor Air Evaluation

There is considerable uncertainty associated with the use of the JEM to estimate indoor air concentrations for risk estimates. The JEM was considered a screening model with the intent that actual indoor air concentrations should not be higher than the modeled concentrations. However, this model has been subject to only limited validation by the USEPA. Consequently, the correlation between model predictions and actual conditions is not clearly understood. Parameters required for implementing the JEM include soil properties (e.g., porosity, moisture content, and bulk density), building properties (e.g., vapor flow rate into building), chemical properties (e.g., VOC concentrations in groundwater, soil, and soil gas), and exposure assumptions for the various receptor populations. The input values used for these parameters were the generic assumptions provided in the MADEP's JEM spreadsheets used to develop the GW-2 Standards (MADEP, 2011). In accordance with the MADEP VI Guidance, site-specific assumptions were not used in the model. Therefore, levels of uncertainty with each parameter vary from low to high depending on the parameter.

The assumptions used in the JEM for estimating indoor air concentrations may either result in potential exposures and risks being under- or over-stated. Uncertainties associated with the assumptions of the model include the following:

- The EPC is based on a modeling method and is not a direct measurement and any uncertainty associated with the model will affect the uncertainty in the exposure estimate. Indoor air concentrations are not likely to be at steady state and probably will fluctuate over the short-term and long-term.

- The model assumes that the EPC (based on the maximum detected groundwater concentration) is present uniformly under the building footprint, overstating potential VI; concentrations in groundwater in proximity to the building may differ than those used in the modeling. Depending on the concentrations closest to the building, the indoor air concentrations used in the HHRAA might have either been under- or over-stated.

- One of the primary practical limitations when the JEM is applied to specific buildings is that the model assumes vertical upward migration into a building directly above the groundwater. However, the groundwater concentrations used as the source to indoor air were measured in monitoring wells not directly adjacent to the specific buildings. When a building is located in an adjacent area, the actual measured indoor air concentrations could differ significantly from those predicted.

- In the estimation of indoor air concentrations from groundwater, the HHRAA conservatively assumed the industrial scenario building dimensions were comparable to that of the default residential scenario building dimensions. However, the industrial buildings may be much larger.

For comparison, indoor air risks were recalculated using indoor air EPCs based on average concentrations for the groundwater wells with the highest detected concentrations for COCs either exceeding the GW-2 criteria or exceeding the MCP limits of 1E-5 for ELCR and HI of 1. The model output for the analytes exceeding the GW-2 criteria or the MCP limits is provided in **Appendix C, Table C-6**; the average groundwater concentration for each analyte is also provided. Detailed calculations are provided in **Appendix A, Tables A-3-18 and A-3-19.** Indoor air risk estimates for the future industrial worker are an ELCR = 8E-06 and HI = 9, primarily associated with 1,2,4-trimethylbenzene. Therefore, it was concluded that indoor air risks for future buildings constructed onsite may exceed MADEP target risk levels.

7 Summary of Results and Findings

Cancer and Non-cancer Health Risks

Current industrial scenarios, as well as future industrial and recreational scenarios, were evaluated for the FMA. These scenarios included the following receptors:

- Current and future industrial workers
- Future on-site recreational users (adult and youth)
- Future construction workers
- Current and future utility workers

The ELCR and non-cancer hazard estimates are summarized below and compared to the MCP limits of 1E-5 for ELCR (for Class A and B carcinogens) and a HI of 1 for non-cancer effects.

Current Scenarios - The estimated ELCR and non-cancer hazards for potential current exposures to soil, demolished concrete, groundwater, and indoor air at the FMA are within MCP limits. Similarly, the estimated risks for potential current exposures to surface water, sediment, and fish in the Shawsheen River are within MCP limits.

Future Scenarios - The estimated ELCR and non-cancer hazards for potential future exposures to soil, demolished concrete, and groundwater at the FMA are within MCP limits. However, vapor modeling from recent groundwater data suggests non-cancer hazards for potential exposure to indoor air at future buildings constructed within the FMA could exceed the MCP non-cancer hazard limit, if no engineered controls (e.g. gas vapor barriers and passive sub-slab venting) are utilized to limit vapor migration into new structures. This is due primarily to the constituents 1,2,4-trimethylbenzene and m/p-xylene. Further intrinsic bioremediation is expected to continue the downward trend in these and other VOC constituents into the future. The estimated risks for potential future recreator exposures to surface water, sediment, and fish in the Shawsheen River are within MCP limits.

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FIGURES

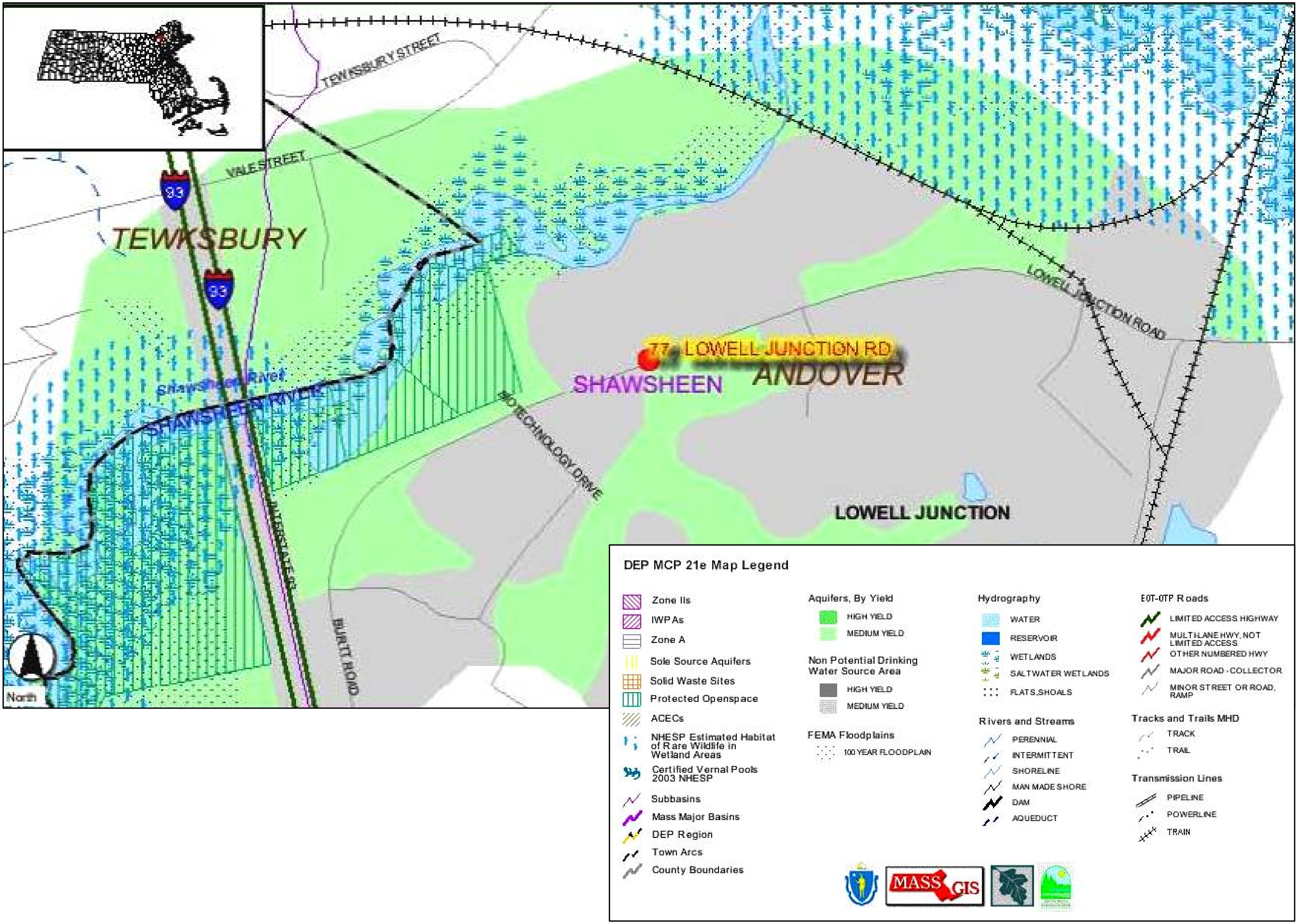

FIGURE 1
MassGIS Priority Resource Map

EXHIBITS

EXHIBIT 1-1
Conceptual Site Model: Exposure Media, Potential Receptors, and Exposure Routes
Reichhold, Inc., Andover, Massachusetts

Timeframe	Exposure Medium	Potential Receptors	Receptor Age	Exposure Route	Remarks
Current	Soil (0-2 ft bgs) at FMA	Industrial Worker	Adult	Dermal	Industrial workers could contact surface soil while working at the site.
				Ingestion	Industrial workers could contact surface soil while working at the site.
				Inhalation	Industrial workers could inhale fugitive emissions from surface soil while working at the site.
	Groundwater at FMA	Industrial Worker	Adult	Inhalation	Industrial workers could access current buildings and may inhale volatile constituents in groundwater that have migrated to indoor air.
Future/Current	Soil (0-6 ft bgs) at FMA	Utility Worker	Adult	Dermal	Utility workers could contact surface and subsurface soil that has been commingled while performing utility activities along the utility corridor.
				Ingestion	Utility workers could contact surface and subsurface soil that has been commingled while performing utility activities along the utility corridor.
				Inhalation	Utility workers could inhale fugitive emissions from surface and subsurface soil that has been commingled while performing utility activities along the utility corridor.
	Groundwater at FMA	Utility Worker	Adult	Dermal	Utility workers could contact groundwater during excavation activities.
				Inhalation	Utility workers could inhale volatile constituents from groundwater during excavation activities.
	Sediment at Shawsheen River	River Recreator	Adult	Dermal	Recreators could come into direct contact with sediment while wading.
			Youth[1]	Dermal	Recreators could come into direct contact with sediment while wading.
	Surface Water at the Shawsheen River	River Recreator	Adult	Ingestion	Recreators could splash surface water into mouth while wading.
				Dermal	Recreators contact surface water while wading.
			Youth[1]	Ingestion	Recreators could splash surface water into mouth while wading.
				Dermal	Recreators contact surface water while wading.
	Fish from Shawsheen River[2]	River Recreator	Adult	Ingestion	Recreational anglers could consume fish caught in the Shawsheen River.
			Youth[1]	Ingestion	Recreational anglers could consume fish caught in the Shawsheen River.
Future	Soil (0-2 ft bgs) at FMA	Onsite Recreator	Adult	Dermal	Recreators could contact surface soil while visiting the site.
				Ingestion	Recreators could contact surface soil while visiting the site.
				Inhalation	Recreators could inhale fugitive emissions from surface soil while visiting the site.
			Youth[1]	Dermal	Recreators could contact surface soil while visiting the site.
				Ingestion	Recreators could contact surface soil while visiting the site.
				Inhalation	Recreators could inhale fugitive emissions from surface soil while visiting the site.
	Total Soil (0-6 ft bgs) at FMA	Industrial Worker	Adult	Dermal	It is conservatively assumed that current subsurface soil could be present at the surface in the future following construction activities. Industrial workers could contact current subsurface soil present at the surface in the future while working at the site.
				Ingestion	It is conservatively assumed that current subsurface soil could be present at the surface in the future following construction activities. Industrial workers could contact current subsurface soil present at the surface in the future while working at the site.
				Inhalation	It is conservatively assumed that current subsurface soil could be present at the surface in the future following construction activities. Industrial workers could inhale fugitive emissions from current subsurface soil present at the surface in the future while working at the site.
		Construction Worker	Adult	Dermal	Construction workers could contact surface and subsurface soil that has been commingled while performing construction activities at the site.
				Ingestion	Construction workers could contact surface and subsurface soil that has been commingled while performing construction activities at the site.
				Inhalation	Construction workers could inhale fugitive emissions from surface and subsurface soil that has been commingled while performing construction activities at the site.
	Demolished Concrete[3]	Industrial Worker	Adult	Dermal	Industrial workers could contact surface fill while working at the site.
				Ingestion	Industrial workers could contact surface fill while working at the site.
				Inhalation	Industrial workers could inhale fugitive emissions from surface fill while working at the site.
		Utility Worker	Adult	Dermal	Utility workers could contact surface fill while performing utility activities along the utility corridor.
				Ingestion	Utility workers could contact surface fill while performing utility activities along the utility corridor.
				Inhalation	Utility workers could inhale fugitive emissions from surface fill while performing utility activities along the utility corridor.
		Construction Worker	Adult	Dermal	Construction workers could contact surface fill while performing construction activities at the site.
				Ingestion	Construction workers could contact surface fill while performing construction activities at the site.
				Inhalation	Construction workers could inhale fugitive emissions from surface fill while performing construction activities at the site.
		Onsite Recreator	Adult	Dermal	Recreators could contact surface fill while visiting the site.
				Ingestion	Recreators could contact surface fill while visiting the site.
				Inhalation	Recreators could inhale fugitive emissions from surface fill while visiting the site.
			Youth[1]	Dermal	Recreators could contact surface fill while visiting the site.
				Ingestion	Recreators could contact surface fill while visiting the site.
				Inhalation	Recreators could inhale fugitive emissions from surface fill while visiting the site.
	Groundwater at FMA	Industrial Worker	Adult	Inhalation	Industrial workers are assumed to primarily work indoors and therefore may inhale volatile constituents in groundwater that have migrated to indoor air.
		Construction Worker	Adult	Dermal	Construction workers could contact groundwater during excavation activities.
				Inhalation	Construction workers could inhale volatile constituents from groundwater during excavation activities.
		Recreator	Adult	Inhalation	Recreators could access current buildings and may inhale volatile constituents in groundwater that have migrated to indoor air.
			Youth[1]	Inhalation	Recreators could access current buildings and may inhale volatile constituents in groundwater that have migrated to indoor air.

Note:
[1] Recreational youth is assumed to be an adolescent (7 to 18 years of age).
[2] Exposure point concentrations for fish ingestion were modeled based on sediment concentrations.
[3] Demolished concrete has been processed for reuse as surficial fill at the FMA.
FMA = Former Manufacturing Area

EXHIBIT 2-1

Occurrence and Distribution of COCs in 0-2 Ft Soil

Reichhold, Inc., Andover, Massachusetts

Receptors:
Current Industrial Worker
Future Onsite Recreational Adult
Future Onsite Recreational Youth
Exposure Medium: Soil (0-2 ft bgs)

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	COC Flag[2]	EPC (mg/kg)[3]	EPC > Maximum Detected	MADEP Soil UCL[4] (mg/kg)
Soil (0-2 ft bgs) at FMA	1,2,4-Trimethylbenzene	95-63-6	mg/kg	3.54E+00	2.00E+02	GP-3	3/19	N/A	Yes	1.11E+01	no	N/A
	1,3,5-Trimethylbenzene	108-67-8	mg/kg	1.78E+00	8.10E+01	GP-3	3/19	N/A	Yes	4.66E+00	no	N/A
	Acetone	67-64-1	mg/kg	1.20E-02	1.00E-01	MFSB8	5/29	N/A	Yes	9.17E-01	yes	1.00E+04
	Ethylbenzene	100-41-4	mg/kg	1.00E-02	1.50E+01	GP-13	6/30	N/A	Yes	9.18E-01	no	1.00E+04
	Isopropylbenzene	98-82-8	mg/kg	2.30E-01	2.30E-01	GP-12	1/19	N/A	Yes	1.08E-01	no	N/A
	n-Butylbenzene	104-51-8	mg/kg	2.60E+01	2.60E+01	GP-3	1/19	N/A	Yes	1.40E+00	no	N/A
	n-Propylbenzene	103-65-1	mg/kg	1.57E-01 J	6.20E+00	GP-3	2/19	N/A	Yes	3.75E-01	no	N/A
	Naphthalene	91-20-3	mg/kg	7.60E-02 J	1.90E+01	GP-3	3/19	N/A	Yes	1.11E+00	no	1.00E+04
	Methyl tert butyl ether	1634-04-4	mg/kg	2.03E-01	2.03E-01	TP-3A	1/19	N/A	Yes	1.87E-01	no	5.00E+03
	Methylene chloride	75-09-2	mg/kg	1.50E-02	1.46E-01	TP-3A	3/29	N/A	Yes	7.13E-01	yes	1.00E+04
	o-Xylene	95-47-6	mg/kg	2.30E-01	1.20E+01	GP-13	6/19	N/A	Yes	1.36E+00	no	1.00E+04
	p-Isopropyltoluene	99-87-6	mg/kg	2.16E-01	2.16E-01	TP-3A	1/19	N/A	Yes	1.05E-01	no	N/A
	p/m-Xylene	OER-100-48	mg/kg	2.20E-03	7.70E+01	GP-3	8/19	N/A	Yes	6.73E+00	no	1.00E+04
	Total Xylenes	1330-20-7	mg/kg	6.00E-03	7.09E-01	TP-3A	5/23	N/A	Yes	2.22E-01	no	1.00E+04
	2,4-Dimethylpheno	105-67-9	mg/kg	4.20E-01	4.20E-01	GP-13	1/21	N/A	Yes	1.90E-01	no	1.00E+04
	3-Methylphenol/4-Methylpheno	OER-101-66	mg/kg	1.30E+00	1.30E+00	GP-13	1/21	N/A	Yes	2.84E-01	no	N/A
	Phenol	108-95-2	mg/kg	3.00E-02 J	4.50E+00	GP-13	6/21	N/A	Yes	5.61E-01	no	1.00E+04
	Benzo(a)pyrene	50-32-8	mg/kg	3.10E-01 J	3.10E-01 J	UB-1	1/6	2.00E+00	No	--[2,3]	yes	3.00E+02
	Benzo(b)fluoranthene	205-99-2	mg/kg	3.30E-01 J	4.42E-01 J	UB-1	2/10	2.00E+00	No	--[2,3]	yes	3.00E+03
	bis(2-Ethylhexyl)phthalate	117-81-7	mg/kg	4.20E-01	4.20E-01	MFSB18	1/10	N/A	Yes	2.64E-01	no	1.00E+04
	Chrysene	218-01-9	mg/kg	2.98E-01 J	2.98E-01 J	UB-1	1/10	2.00E+00	No	--[2,3]	yes	1.00E+04
	Fluoranthene	206-44-0	mg/kg	3.14E-01 J	4.33E-01 J	TP-2	3/10	4.00E+00	No	--[2,3]	yes	1.00E+04
	Pyrene	129-00-0	mg/kg	2.91E-01 J	4.14E-01 J	UB-1	3/10	4.00E+00	No	--[2,3]	yes	1.00E+04
	Arsenic	7440-38-2	mg/kg	1.11E+00	1.30E+01	TP-2	7/7	2.00E+01	No	--[2,3]	yes	2.00E+02
	Barium	7440-39-3	mg/kg	7.00E+00	7.70E+01	TP-2	7/7	5.00E+01	Yes	2.59E+01	no	1.00E+04
	Cadmium	7440-43-9	mg/kg	1.50E-01 J	5.50E+00	MFSB13	17/18	2.00E+00	Yes	1.14E+00	no	3.00E+02
	Chromium	7440-47-3	mg/kg	6.20E+00	2.29E+01	MFSB20	7/7	3.00E+01	No	--[2,3]	yes	2.00E+03
	Copper	7440-50-8	mg/kg	3.10E+00	2.50E+02	MFSB15	20/20	4.00E+01	Yes	2.24E+01	no	N/A
	Iron	7439-89-6	mg/kg	4.26E+03	3.10E+04	MFSB9	15/15	2.00E+04	Yes	1.03E+04	no	N/A
	Lead	7439-92-1	mg/kg	1.60E+00	7.60E+01	UB-1	15/15	1.00E+02	No	--[2,3]	yes	3.00E+03
	Mercury	7439-97-6	mg/kg	4.00E-02 B	1.30E-01	TP-2	4/7	3.00E-01	No	--[2,3]	yes	3.00E+02
	Silver	7440-22-4	mg/kg	1.50E-01 J	6.00E-01 B	MFSB15	3/7	6.00E-01	Yes	2.86E-01	no	2.00E+03
	Zinc	7440-66-6	mg/kg	1.90E+01	5.90E+02	FMA-HS-8-0-2	18/18	1.00E+02	Yes	1.31E+02	no	1.00E+04

Note:

[1] Background values were obtained from MADEP's technical update, "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil" (MADEP, 2002).
[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
[4] MCP Method 3: UCLs in Groundwater and Soil. Retrieved August 2012, from http://www.mass.gov/dep/cleanup/laws/0996_7.htm.
COC = Chemical of Concern
EPC = Exposure Point Concentration
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
UCL = Upper Concentration Limits
J = Estimated value
B = Analyte detected in sample and blank
N/A - Not Available

EXHIBIT 2-2
Occurrence and Distribution of COCs in 0-6 Ft Soil
Reichhold, Inc., Andover, Massachusetts

Receptors:
Future Industrial Worker
Future Construction Worker
Exposure Medium: Soil (0 - 6 ft bgs)

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	COC Flag[2]	EPC (mg/kg)[3]	EPC > Maximum Detected	MADEP Soil UCL[4] (mg/kg)
Soil (0 - 6 ft bgs) at FMA	1,2,4-Trimethylbenzene	95-63-6	mg/kg	1.40E-02	2.08E+03	TP-5	13/38	N/A	Yes	1.37E+02	no	N/A
	1,2-Dichlorobenzene	95-50-1	mg/kg	1.50E-02	3.94E+01 J	TP-5	2/38	N/A	Yes	2.31E+00	no	1.00E+04
	1,3,5-Trimethylbenzene	108-67-8	mg/kg	5.40E-03	6.35E+02	TP-5	12/38	N/A	Yes	4.56E+01	no	N/A
	1,4-Dichlorobenzene	106-46-7	mg/kg	3.00E-03	3.00E-03	UB-5	1/32	N/A	Yes	1.25E+00	yes	1.00E+04
	2-Butanone	78-93-3	mg/kg	4.50E-02	4.50E-02	UB-5	1/32	N/A	Yes	1.04E+01	yes	1.00E+04
	4-Methyl-2-pentanone	108-10-1	mg/kg	5.20E-02	5.20E-02	MFSB11	1/51	N/A	Yes	8.41E+00	yes	1.00E+04
	Acetone	67-64-1	mg/kg	1.20E-02	3.70E+01	TP-3	11/51	N/A	Yes	8.69E+00	no	1.00E+04
	Benzene	71-43-2	mg/kg	9.00E-03	9.00E-03	MFA-TF3	1/59	N/A	Yes	8.86E-01	yes	9.00E+03
	Carbon disulfide	75-15-0	mg/kg	2.00E-03 J	2.00E-03 J	UB-5	1/32	N/A	Yes	1.48E+00	yes	N/A
	Chlorobenzene	108-90-7	mg/kg	2.20E-03	5.42E+01 J	TP-5	4/34	N/A	Yes	1.78E+00	no	1.00E+04
	Ethylbenzene	100-41-4	mg/kg	2.10E-03	1.40E+02	MFA-113	34/79	N/A	Yes	8.50E+00	no	1.00E+04
	Isopropylbenzene	98-82-8	mg/kg	1.30E-03	3.57E+01 J	TP-5	8/37	N/A	Yes	1.91E+00	no	N/A
	n-Butylbenzene	104-51-8	mg/kg	1.90E-02	1.20E+02	TP-9	7/38	N/A	Yes	1.00E+01	no	N/A
	n-Propylbenzene	103-65-1	mg/kg	2.00E-03 J	6.28E+01	TP-5	10/38	N/A	Yes	4.10E+00	no	N/A
	Naphthalene	91-20-3	mg/kg	4.00E-03	1.82E+02	TP-5	20/60	N/A	Yes	9.51E+00	no	1.00E+04
	Methyl tert butyl ether	1634-04-4	mg/kg	1.20E-02	2.03E-01	TP-3A	2/60	N/A	Yes	1.06E+00	yes	5.00E+03
	Methylene chloride	75-09-2	mg/kg	1.50E-02	1.46E-01	TP-3A	4/51	N/A	Yes	5.12E+00	yes	1.00E+04
	o-Xylene	95-47-6	mg/kg	2.40E-03	1.40E+02	TP-3	15/38	N/A	Yes	1.10E+01	no	1.00E+04
	p-Isopropyltoluene	99-87-6	mg/kg	1.89E-01	1.00E+01	TP-6	7/38	N/A	Yes	1.65E+00	no	N/A
	p/m-Xylene	OER-100-48	mg/kg	2.20E-03	7.39E+02	TP-5	18/38	N/A	Yes	6.20E+01	no	1.00E+04
	sec-Butylbenzene	135-98-8	mg/kg	3.40E-01	4.10E+00	TP-6	3/38	N/A	Yes	1.20E+00	no	N/A
	Styrene	100-42-5	mg/kg	4.10E-02	1.40E+02	MFA-STYR4	4/42	N/A	Yes	5.58E+00	no	1.00E+04
	Toluene	108-88-3	mg/kg	1.00E-02	6.00E+01	MFA-KBSW2	3/60	N/A	Yes	1.95E+00	no	1.00E+04
	Total Xylenes	1330-20-7	mg/kg	6.00E-03	2.10E+03 J	MFSB10	37/67	N/A	Yes	1.21E+02	no	1.00E+04
	2,4-Dimethylphenol	105-67-9	mg/kg	4.20E-01	1.30E+00 J	MFSB11	2/41	N/A	Yes	4.25E-01	no	1.00E+04
	3-Methylphenol/4-Methylphenol	OER-101-66	mg/kg	6.90E-01 J	2.60E+00	MFA-TF2	4/45	N/A	Yes	5.47E-01	no	N/A
	Phenol	108-95-2	mg/kg	3.00E-02 J	5.60E+02	MFSB10	11/46	N/A	Yes	1.30E+01	no	1.00E+04
	2-Methylnaphthalene	91-57-6	mg/kg	1.15E+01 E	1.15E+01 E	TP-5	1/13	5.00E-01	Yes	1.15E+00	no	5.00E+03
	Acenaphthene	83-32-9	mg/kg	4.29E-01 J	4.29E-01 J	TP-5	1/13	5.00E-01	No	--[2,3]	yes	1.00E+04
	Anthracene	120-12-7	mg/kg	9.74E-01	9.74E-01	TP-5	1/13	1.00E+00	No	--[2,3]	yes	1.00E+04
	Benzo(a)anthracene	56-55-3	mg/kg	1.34E+00	1.34E+00	TP-5	1/18	2.00E+00	No	--[2,3]	yes	3.00E+03
	Benzo(a)pyrene	50-32-8	mg/kg	3.10E-01 J	1.00E+00	TP-5	2/13	2.00E+00	No	--[2,3]	yes	3.00E+02
	Benzo(b)fluoranthene	205-99-2	mg/kg	3.30E-01 J	1.26E+00	TP-5	3/18	2.00E+00	No	--[2,3]	yes	3.00E+03
	Benzo(ghi)perylene	191-24-2	mg/kg	5.82E-01 J	5.82E-01 J	TP-5	1/13	1.00E+00	No	--[2,3]	yes	1.00E+04
	Benzo(k)fluoranthene	207-08-9	mg/kg	4.00E-01 J	4.00E-01 J	TP-5	1/18	1.00E+00	No	--[2,3]	yes	1.00E+04
	bis(2-Ethylhexyl)phthalate	117-81-7	mg/kg	4.20E-01	4.20E-01	MFSB18	1/18	N/A	Yes	2.76E-01	no	1.00E+04
	Chrysene	218-01-9	mg/kg	2.98E-01 J	1.19E+00	TP-5	2/18	2.00E+00	No	--[2,3]	yes	1.00E+04
	Dibenzofuran	132-64-9	mg/kg	4.29E-01 J	4.29E-01 J	TP-5	1/13	N/A	Yes	3.01E-01	no	N/A
	Fluoranthene	206-44-0	mg/kg	3.14E-01 J	3.77E+00	TP-5	5/18	4.00E+00	No	--[2,3]	yes	1.00E+04
	Fluorene	86-73-7	mg/kg	6.85E-01	6.85E-01	TP-5	1/13	1.00E+00	No	--[2,3]	yes	1.00E+04
	Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	6.66E-01	6.66E-01	TP-5	1/13	1.00E+00	No	--[2,3]	yes	3.00E+03
	Phenanthrene	85-01-8	mg/kg	3.67E-01 J	4.34E+00	TP-5	2/13	3.00E+00	Yes	6.08E-01	no	1.00E+04
	Pyrene	129-00-0	mg/kg	2.91E-01	2.96E+00	TP-5	5/18	4.00E+00	No	--[2,3]	yes	1.00E+04
	Arsenic	7440-38-2	mg/kg	1.11E+00	2.20E+01	TP-1	13/13	2.00E+01	Yes	7.79E+00	no	2.00E+02
	Barium	7440-39-3	mg/kg	7.00E+00	7.70E+01	TP-2	13/13	5.00E+01	Yes	2.21E+01	no	1.00E+04
	Cadmium	7440-43-9	mg/kg	8.60E-02 J	4.38E+01	MFSB-2	31/33	2.00E+00	Yes	4.72E+00	no	3.00E+02
	Chromium	7440-47-3	mg/kg	6.20E+00	4.20E+01	TP-3	13/13	3.00E+01	Yes	1.69E+01	no	2.00E+03
	Copper	7440-50-8	mg/kg	1.90E+00	2.50E+02	MFSB15	34/34	4.00E+01	Yes	1.64E+01	no	N/A
	Iron	7439-89-6	mg/kg	1.90E+03	3.10E+04	MFSB9	24/24	2.00E+04	Yes	9.48E+03	no	N/A
	Lead	7439-92-1	mg/kg	1.60E+00	2.27E+02	MFSB-2	24/24	1.00E+02	Yes	2.32E+01	no	3.00E+03
	Mercury	7439-97-6	mg/kg	4.00E-02 B	1.30E-01	TP-2	5/13	3.00E-01	No	--[2,3]	yes	3.00E+02
	Silver	7440-22-4	mg/kg	1.50E-01 J	6.00E-01 B	MFSB15	4/13	6.00E-01	Yes	2.99E-01	no	2.00E+03
	Zinc	7440-66-6	mg/kg	1.20E+01	6.00E+03	UB-6	33/33	1.00E+02	Yes	7.43E+02	no	1.00E+04

Note:
[1] Background values were obtained from MADEP's technical update, "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil" (MADEP, 2002).
[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
[4] MCP Method 3: UCLs in Groundwater and Soil. Retrieved August 2012, from http://www.mass.gov/dep/cleanup/laws/0996_7.htm.
COC = Chemical of Concern
EPC = Exposure Point Concentration
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
UCL = Upper Concentration Limits
J = Estimated value
B = Analyte detected in sample and blank
E = Exceeds calibration range
N/A - Not Available

EXHIBIT 2-3

Occurrence and Distribution of COCs in 0-6 Ft Soil in the Utility Corridor

Reichhold, Inc., Andover, Massachusetts

Receptor: Current/Future Utility Worker
Exposure Medium: Soil (0-6 ft bgs)

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	COC Flag[2]	EPC (mg/kg)[3]	EPC > Maximum Detected	MADEP Soil UCL[4] (mg/kg)
Soil (0-6 ft bgs) at FMA Utility Corridor	1,2,4-Trimethylbenzene	95-63-6	mg/kg	1.70E-02	1.75E+00	UB-6	2/11	N/A	Yes	2.43E-01	no	N/A
	1,3,5-Trimethylbenzene	108-67-8	mg/kg	5.24E-01 J	5.24E-01 J	UB-6	1/11	N/A	Yes	1.30E-01	no	N/A
	1,4-Dichlorobenzene	106-46-7	mg/kg	3.00E-03	3.00E-03	UB-5	1/11	N/A	Yes	1.17E-01	yes	1.00E+04
	2-Butanone	78-93-3	mg/kg	4.50E-02	4.50E-02	UB-5	1/11	N/A	Yes	3.38E-01	yes	1.00E+04
	Acetone	67-64-1	mg/kg	1.20E-02	2.05E-01	UB-5	2/11	N/A	Yes	3.54E-01	yes	1.00E+04
	Carbon disulfide	75-15-0	mg/kg	2.00E-03 J	2.00E-03 J	UB-5	1/11	N/A	Yes	1.94E-01	yes	N/A
	Chlorobenzene	108-90-7	mg/kg	1.80E-02	4.37E-01 J	UB-6	2/11	N/A	Yes	5.81E-02	no	1.00E+04
	Ethylbenzene	100-41-4	mg/kg	1.50E+01	1.50E+01	GP-13	1/11	N/A	Yes	1.40E+00	no	1.00E+04
	n-Propylbenzene	103-65-1	mg/kg	2.00E-03 J	2.00E-03 J	UB-5	1/11	N/A	Yes	5.11E-02	yes	N/A
	Naphthalene	91-20-3	mg/kg	4.00E-03	4.00E-03	UB-5	1/11	N/A	Yes	1.17E-01	yes	1.00E+04
	o-Xylene	95-47-6	mg/kg	1.07E+01	1.20E+01	GP-13	2/11	N/A	Yes	2.06E+00	no	1.00E+04
	p/m-Xylene	OER-100-48	mg/kg	4.20E-02	6.47E+01	UB-6	3/11	N/A	Yes	9.89E+00	no	1.00E+04
	Total Xylenes	1330-20-7	mg/kg	4.35E-02	7.54E+01	UB-6	2/10	N/A	Yes	7.55E+00	no	1.00E+04
	2,4-Dimethylphenol	105-67-9	mg/kg	4.20E-01	4.20E-01	GP-13	1/11	N/A	Yes	3.07E-01	no	1.00E+04
	3-Methylphenol/4-Methylphenol	OER-101-66	mg/kg	1.30E+00	1.30E+00	GP-13	1/11	N/A	Yes	4.94E-01	no	N/A
	Phenol	108-95-2	mg/kg	4.50E+00	4.50E+00	GP-13	1/11	N/A	Yes	7.85E-01	no	1.00E+04
	Cadmium	7440-43-9	mg/kg	3.10E-01	8.40E+00	UB-6	2/2	2.00E+00	Yes	4.36E+00	no	3.00E+02
	Zinc	7440-66-6	mg/kg	3.00E+01	6.00E+03	UB-6	2/2	1.00E+02	Yes	3.02E+03	no	1.00E+04

Note:

[1] Background values were obtained from MADEP's technical update, "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil" (MADEP, 2002).

[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.

[3] EPC was calculated as the mean concentration only for chemicals identified as COC.

[4] MCP Method 3: UCLs in Groundwater and Soil. Retrieved August 2012, from http://www.mass.gov/dep/cleanup/laws/0996_7.htm.

COC = Chemical of Concern
EPC = Exposure Point Concentration
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
UCL = Upper Concentration Limits
J = Estimated value
N/A - Not Available

EXHIBIT 2-4

Occurrence and Distribution of COCs in Demolished Concrete[1]

Reichhold, Inc., Andover, Massachusetts

Receptors:
Future Industrial Worker
Future Utility Worker
Future Construction Worker
Future Onsite Recreational Adult
Future Onsite Recreational Youth
Exposure Medium: Demolished Concrete

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Background Value[2]	COC Flag[3]	EPC (mg/kg)[4]	EPC > Maximum Detected	Method 1 S-1 Soil Standards[5] (mg/kg)
	Acetone	67-64-1	mg/kg	1.10E-02	5.50E-02	CP-TF-Stain	5/10	N/A	Yes	2.83E-02	no	6.00E+00
Concrete	p/m-Xylene	OER-100-48	mg/kg	4.00E-03	4.00E-03	CP-Garage	1/10	N/A	Yes	4.00E-03	no	4.00E+02
(Surficial Fill)	Fluoranthene	206-44-0	mg/kg	2.61E-01	2.61E-01	CP-TF-Stain	1/5	4.00E+00	No	2.58E-01	--[3,4]	1.00E+03
	Phenol	108-95-2	mg/kg	5.61E-01 J	6.07E+00	CP-Pilot	2/5	N/A	Yes	3.32E+00	no	1.00E+00
	C19-C36 Aliphatics	N/A	mg/kg	3.23E+01	5.12E+01	CP-Stockroom	4/5	N/A	Yes	3.87E+01	no	3.00E+03
	Arsenic	7440-38-2	mg/kg	3.10E+00	1.60E+01	CP-TF-Clean	5/5	2.00E+01	No	8.58E+00	--[3,4]	2.00E+01
	Barium	7440-39-3	mg/kg	4.50E+01	7.80E+01	CP-TF-Stain	5/5	5.00E+01	Yes	5.78E+01	no	1.00E+03
	Cadmium[6]	7440-43-9	mg/kg	3.20E-01	3.50E+00	CP-TF-Stain	5/5	2.00E+00	Yes	1.21E+00	no	2.00E+00
	Chromium (Total)	7440-47-3	mg/kg	1.40E+01	5.10E+01	CP-Garage	5/5	3.00E+01	Yes	3.52E+01	no	3.00E+01
	Chromium (III)	16065-83-1	mg/kg	3.90E+01	5.10E+01	CP-Garage	3/3	3.00E+01	Yes	4.33E+01	no	1.00E+03
	Chromium (VI)	7440-47-3	mg/kg	9.50E-01	9.50E-01	CP-TF-Stain	1/3	3.00E+01	No	9.50E-01	--[3,4]	3.00E+01
	Copper	7440-50-8	mg/kg	7.80E+00	6.10E+01	CP-TF-Stain	5/5	4.00E+01	Yes	2.91E+01	no	N/A
	Iron	7439-89-6	mg/kg	9.60E+03	2.70E+04	CP-TF-Stain	5/5	2.00E+04	Yes	1.76E+04	no	N/A
	Lead	7439-92-1	mg/kg	4.00E+00	8.50E+00	CP-Stockroom	5/5	1.00E+02	No	6.95E+00	--[3,4]	3.00E+02
	Mercury	7439-97-6	mg/kg	8.50E-02	8.50E-02	CP-TF-Stain	1/5	3.00E-01	No	8.10E-02	--[3,4]	2.00E+01
	Zinc	7440-66-6	mg/kg	3.00E+01	2.10E+02	CP-TF-Stain	5/5	1.00E+02	Yes	1.15E+02	no	2.50E+03

Notes:

[1] Processed concrete may be used as surficial fill across the FMA.

[2] Background values were obtained from MADEP's technical update, "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil" (MADEP, 2002).

[3] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.

[4] EPC was calculated as the mean concentration only for chemicals identified as COC.

[5] MCP Method 1: S-1 Soil Standards (GW-1). Retrieved August 2012, fromhttp://www.mass.gov/dep/cleanup/laws/0975_6a.htm.

[6] Cadmium results for samples CP-TF-Stain and CP-DUP were re-run at the laboratory. The maximium result is provided.

COC = Chemical of Concern
EPC = Exposure Point Concentration
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
J = Estimated value
N/A - Not Available

EXHIBIT 2-5
Occurrence and Distribution of COCs in All Groundwater
Reichhold, Inc., Andover, Massachusetts

Receptor:
Future Industrial Worker
Future Construction Worker
Exposure Medium: Groundwater

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration		Maximum Detected Concentration		Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	COC Flag[2]	EPC Groundwater[3] (ug/L)	EPC > Maximum Detected	MADEP GW-2	EPC < GW-2	MADEP GW-3	EPC < GW-3	MADEP Groundwater UCL[4] (ug/L)	EPC<UCL
Groundwater at FMA	1,2,4-Trimethylbenzene	95-63-6	ug/L	5.00E-01		5.09E+03		GP-6	58 / 85	N/A	Yes	4.82E+02	no	--	--	--	--	--	--
	1,2-Dichlorobenzene	95-50-1	ug/L	6.00E-01	J	2.00E+01		GP-02	27 / 85	N/A	Yes	8.30E+00	no	2.00E+03	yes	2.00E+03	yes	2.00E+04	yes
	1,2-Dichloroethane	107-06-2	ug/L	8.00E-01	J	1.80E+00		GP-10	3 / 85	N/A	Yes	2.93E+00	yes	5.00E+00	yes	2.00E+04	yes	1.00E+05	yes
	1,3,5-Trimethylbenzene	108-67-8	ug/L	1.40E+00		1.80E+03		GP-6	41 / 85	N/A	Yes	1.26E+02	no	--	--	--	--	--	--
	1,3-Dichlorobenzene	541-73-1	ug/L	6.00E-01	J	4.60E+00	J	GP-10	9 / 85	N/A	Yes	8.84E+00	yes	2.00E+03	yes	5.00E+04	yes	1.00E+05	yes
	1,4-Dichlorobenzene	106-46-7	ug/L	6.00E-01	J	8.60E+01		GP-10	28 / 85	N/A	Yes	1.34E+01	no	2.00E+02	yes	8.00E+03	yes	8.00E+04	yes
	2,4-Dichlorophenol	120-83-2	ug/L	2.30E+01		2.30E+01		GP-02	1 / 41	N/A	Yes	3.00E+00	no	3.00E+04	yes	2.00E+03	yes	1.00E+05	yes
	2,4-Dimethylphenol	105-67-9	ug/L	4.00E+00	J	1.90E+01		GP-8	10 / 41	N/A	Yes	4.48E+00	no	4.00E+04	yes	5.00E+04	yes	1.00E+05	yes
	2-Methylnaphthalene	91-57-6	ug/L	1.40E+00		1.40E+00		UB-6	1 / 4	N/A	Yes	4.25E-01	no	2.00E+03	yes	2.00E+04	yes	1.00E+05	yes
	3-Methylphenol/4-Methylphenol	OER-101-66	ug/L	6.00E+00		6.00E+00		GP-12	1 / 41	N/A	Yes	2.59E+00	no	--	--	--	--	--	--
	4-Methyl-2-pentanone	108-10-1	ug/L	7.65E+02		7.65E+02		GP-13	1 / 85	N/A	Yes	3.74E+01	no	5.00E+04	yes	5.00E+04	yes	1.00E+05	yes
	Acetone	67-64-1	ug/L	5.60E+00	J	9.00E+00	J	GP-8	3 / 85	N/A	Yes	2.89E+01	yes	5.00E+04	yes	5.00E+04	yes	1.00E+05	yes
	Arsenic	7440-38-2	ug/L	9.00E+00		1.60E+02		GM-2	7 / 10	5.50E+00	Yes	5.16E+01	no	NA	--	9.00E+02	yes	9.00E+03	yes
	Barium	7440-39-3	ug/L	5.30E+00	J	2.70E+01		UB-6	4 / 4	N/A	Yes	1.58E+01	no	NA	--	5.00E+04	yes	1.00E+05	yes
	Benzene	71-43-2	ug/L	5.00E-01	J	1.09E+02		GP-11	19 / 85	N/A	Yes	5.54E+00	no	2.00E+03	yes	1.00E+04	yes	1.00E+05	yes
	Benzo(a)pyrene	50-32-8	ug/L	3.00E-01		3.00E-01		UB-1	2 / 4	N/A	Yes	2.00E-01	no	NA	--	5.00E+02	yes	5.00E+03	yes
	Benzo(b)fluoranthene	205-99-2	ug/L	3.00E-01		3.00E-01		UB-1	2 / 4	N/A	Yes	2.00E-01	no	NA	--	4.00E+02	yes	4.00E+03	yes
	Benzo(ghi)perylene	191-24-2	ug/L	2.00E-01		3.00E-01		UB-1	2 / 4	N/A	Yes	1.75E-01	no	NA	--	2.00E+01	yes	5.00E+02	yes
	Cadmium	7440-43-9	ug/L	1.60E-01	B	1.70E-01	B	UB-5	2 / 4	4.20E+00	No	--[2,3]	--	NA	--	4.00E+00	--	5.00E+01	--
	Chlorobenzene	108-90-7	ug/L	6.00E-01	J	1.58E+03		GP-11	49 / 85	N/A	Yes	4.37E+01	no	2.00E+02	yes	1.00E+03	yes	1.00E+04	yes
	Chromium	7440-47-3	ug/L	3.70E+00	B	3.70E+00	B	UB-6	1 / 4	4.90E+00	No	--[2,3]	--	NA	--	3.00E+02	--	3.00E+03	--
	Dibenzo(a,h)anthracene	53-70-3	ug/L	4.00E-01		4.00E-01		UB-1	1 / 4	N/A	Yes	1.75E-01	no	NA	--	4.00E+01	yes	4.00E+02	yes
	Ethylbenzene	100-41-4	ug/L	7.00E-01	J	1.56E+04		CHMW-13	58 / 85	N/A	Yes	5.32E+02	no	2.00E+04	yes	5.00E+03	yes	1.00E+05	yes
	Fluorene	86-73-7	ug/L	3.00E-01		3.00E-01		UB-6	1 / 4	N/A	Yes	1.50E-01	no	NA	--	4.00E+01	yes	4.00E+02	yes
	Formaldehyde	50-00-0	ug/L	6.27E+00		6.27E+00		GP-16	1 / 2	N/A	Yes	4.39E+00	no	--	--	--	--	--	--
	Indeno(1,2,3-cd)Pyrene	193-39-5	ug/L	4.00E-01		5.00E-01		UB-1	2 / 4	N/A	Yes	2.75E-01	no	NA	--	1.00E+02	yes	1.00E+03	yes
	Iron	7439-89-6	ug/L	1.20E+01		9.50E+03	B	UB-5	4 / 4	N/A	Yes	4.26E+03	no	--	--	--	--	--	--
	Isopropylbenzene	98-82-8	ug/L	6.00E-01	J	9.50E+01		GP-10	54 / 85	N/A	Yes	2.16E+01	no	--	--	--	--	--	--
	Manganese	7439-96-5	ug/L	1.60E+02		3.50E+03		GM-2	6 / 6	N/A	Yes	1.15E+03	no	--	--	--	--	--	--
	Mercury	7439-97-6	ug/L	7.20E-02	J	7.20E-02	J	UB-5	1 / 4	9.50E-01	No	--[2,3]	--	NA	--	2.00E+01	--	2.00E+02	--
	Methyl tert butyl ether	1634-04-4	ug/L	6.00E-01	J	1.00E+01		GP-03	5 / 85	N/A	Yes	4.23E+00	no	5.00E+04	yes	5.00E+04	yes	1.00E+05	yes
	Naphthalene	91-20-3	ug/L	1.20E+00		2.63E+02		GP-6	47 / 85	N/A	Yes	3.15E+01	no	1.00E+03	yes	2.00E+04	yes	1.00E+05	yes
	n-Butylbenzene	104-51-8	ug/L	2.40E+00		5.80E+01		GP-10	12 / 85	N/A	Yes	6.08E+00	no	--	--	--	--	--	--
	n-Propylbenzene	103-65-1	ug/L	6.00E-01		1.09E+02		GP-6	51 / 85	N/A	Yes	1.93E+01	no	--	--	--	--	--	--
	o-Xylene	95-47-6	ug/L	6.00E-01		1.90E+03		GP-08	50 / 85	N/A	Yes	1.16E+02	no	--	--	5.00E+03	yes	1.00E+05	yes
	p/m-Xylene	OER-100-48	ug/L	5.00E-01	J	6.90E+03		GP-05	60 / 85	N/A	Yes	6.47E+02	no	--	--	5.00E+03	yes	1.00E+05	yes
	Phenanthrene	85-01-8	ug/L	5.00E-01		5.00E-01		UB-6	1 / 4	N/A	Yes	2.00E-01	no	NA	--	1.00E+04	yes	1.00E+05	yes
	Phenol	108-95-2	ug/L	4.70E+01		7.40E+01		GP-5	2 / 42	N/A	Yes	5.26E+00	no	5.00E+04	yes	2.00E+03	yes	1.00E+05	yes
	p-Isopropyltoluene	99-87-6	ug/L	5.00E-01	J	1.56E+02		GP-6	35 / 85	N/A	Yes	1.44E+01	no	--	--	--	--	--	--
	sec-Butylbenzene	135-98-8	ug/L	3.40E+00		3.40E+00		CHMW-9	1 / 85	N/A	Yes	4.08E+00	yes	--	--	--	--	--	--
	Styrene	100-42-5	ug/L	1.15E+02		1.15E+02		CHMW-13	1 / 85	N/A	Yes	5.39E+00	no	1.00E+02	yes	6.00E+03	yes	6.00E+04	yes
	tert-Butylbenzene	98-06-6	ug/L	9.00E-01	J	9.00E-01	J	GP-8	1 / 85	N/A	Yes	2.58E+01	yes	--	--	--	--	--	--
	Tertiary-Amyl Methyl Ether	994-05-8	ug/L	6.00E-01	J	5.60E+00		GP-03	2 / 85	N/A	Yes	6.47E+00	yes	--	--	--	--	--	--
	Toluene	108-88-3	ug/L	1.20E+00		6.30E+01		GP-03	19 / 85	N/A	Yes	7.31E+00	no	5.00E+04	yes	4.00E+04	yes	1.00E+05	yes
	Zinc	7440-66-6	ug/L	5.90E+00	J	2.20E+01	J	UB-5	2 / 4	N/A	Yes	1.95E+01	no	NA	--	9.00E+02	yes	5.00E+04	yes

Note:
[1] Background values were obtained from MADEP's Numerical Standards Spreadsheets (MADEP, 2009).
[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
[4] MCP Method 3: UCLs in Groundwater and Soil. Retrieved August 2012, from http://www.mass.gov/dep/cleanup/laws/0996_7.htm.
COC = Chemical of Concern
EPC = Exposure Point Concentration
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
UCL = Upper Concentration Limits
J = Estimated value
B = Analyte detected in sample and blank
E = Exceeds calibration range
N/A = not available
-- not included in the MADEP's GW-2, GW-3 Standards or UCLs

EXHIBIT 2-6
Occurrence and Distribution of COCs in Groundwater Near the Existing Buildings
Reichhold, Inc., Andover, Massachusetts

Receptors:
Current Industrial Worker
Future Onsite Recreational Adult
Future Onsite Recreational Youth
Exposure Medium: Groundwater

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration		Maximum Detected Concentration		Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	MADEP GW-2	EPC < GW-2
Groundwater at FMA Office Building and Warehouse	Methyl tert butyl ether	1634-04-4	ug/L	6.00E-01	J	2.70E+00		UB-3	3/6	N/A	5.00E+04	Yes
	Benzo(a)pyrene	50-32-8	ug/L	3.00E-01		3.00E-01		UB-1	1/2	N/A	N/A	N/A
	Benzo(b)fluoranthene	205-99-2	ug/L	3.00E-01		3.00E-01		UB-1	1/2	N/A	N/A	N/A
	Benzo(ghi)perylene	191-24-2	ug/L	3.00E-01		3.00E-01		UB-1	1/2	N/A	N/A	N/A
	Dibenzo(a,h)anthracene	53-70-3	ug/L	4.00E-01		4.00E-01		UB-1	1/2	N/A	N/A	N/A
	Indeno(1,2,3-cd)Pyrene	193-39-5	ug/L	5.00E-01		5.00E-01		UB-1	1/2	N/A	N/A	N/A
	Barium	7440-39-3	ug/L	5.30E+00	J	6.70E+00	J	UB-1	2/2	N/A	N/A	N/A
	Iron	7439-89-6	ug/L	1.20E+01	JB	3.20E+02	B	UB-8	2/2	N/A	--	--

Note:
[1] Background values were obtained from MADEP's Numerical Standards Spreadsheets (MADEP, 2009).
[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.
COC = Chemical of Concern
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
J = Estimated value
B = Analyte detected in sample and blank
N/A - Not Available

EXHIBIT 2-7
Occurrence and Distribution of COCs in Groundwater Within the Existing Utility Corridor
Reichhold, Inc., Andover, Massachusetts

Receptor: Current/Future Utility Worker
Exposure Medium: Groundwater

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Background Value[1]	COC Flag[2]	EPC Groundwater[3] (ug/L)	MADEP Groundwater UCL[4] (ug/L)
Groundwater at FMA Utility Corridor	1,2,4-Trimethylbenzene	95-63-6	ug/L	7.52E+02	9.45E+02 E	UB-6	2/7	N/A	Yes	2.43E+02	N/A
	1,2-Dichlorobenzene	95-50-1	ug/L	1.80E+00	5.50E+00	UB-5	3/7	N/A	Yes	2.59E+00	2.00E+04
	1,3,5-Trimethylbenzene	108-67-8	ug/L	1.30E+01	7.20E+01	GP-13	2/7	N/A	Yes	1.25E+01	N/A
	1,3-Dichlorobenzene	541-73-1	ug/L	9.00E-01 J	9.00E-01 J	UB-6	1/7	N/A	Yes	1.20E+00	1.00E+05
	1,4-Dichlorobenzene	106-46-7	ug/L	9.00E-01	1.60E+01	GP-13	4/7	N/A	Yes	3.91E+00	8.00E+04
	4-Methyl-2-pentanone	108-10-1	ug/L	7.65E+02	7.65E+02	GP-13	1/7	N/A	Yes	1.14E+02	1.00E+05
	Acetone	67-64-1	ug/L	5.60E+00 J	5.60E+00 J	UB-6	1/7	N/A	Yes	1.15E+01	1.00E+05
	Benzene	71-43-2	ug/L	9.00E-01 J	1.20E+00	UB-6	2/7	N/A	Yes	1.30E+00	1.00E+05
	Chlorobenzene	108-90-7	ug/L	3.50E+00	6.20E+01	GP-13	4/7	N/A	Yes	1.56E+01	1.00E+04
	Ethylbenzene	100-41-4	ug/L	8.00E-01 J	3.60E+01	GP-13	3/7	N/A	Yes	9.26E+00	1.00E+05
	Isopropylbenzene	98-82-8	ug/L	6.00E-01 J	6.20E+01	UB-6	4/7	N/A	Yes	1.64E+01	N/A
	Methyl tert butyl ether	1634-04-4	ug/L	6.00E-01 J	2.70E+00	UB-3	3/7	N/A	Yes	1.64E+00	1.00E+05
	n-Butylbenzene	104-51-8	ug/L	5.00E+01	5.00E+01	UB-6	1/7	N/A	Yes	8.21E+00	N/A
	n-Propylbenzene	103-65-1	ug/L	5.80E+01	6.40E+01	UB-6	2/7	N/A	Yes	1.78E+01	N/A
	Naphthalene	91-20-3	ug/L	3.40E+01	4.20E+01	GP-13	2/7	N/A	Yes	1.12E+01	1.00E+05
	o-Xylene	95-47-6	ug/L	2.60E+01	1.00E+03	GP-13	2/7	N/A	Yes	1.48E+01	N/A
	p-Isopropyltoluene	99-87-6	ug/L	6.00E+00	6.00E+00	GP-13	1/7	N/A	Yes	1.29E+00	N/A
	p/m-Xylene	OER-100-48	ug/L	2.60E+00	4.40E+03	GP-13	3/7	N/A	Yes	1.14E+02	N/A
	Toluene	108-88-3	ug/L	2.40E+00	2.40E+02	GP-13	3/7	N/A	Yes	3.86E+00	1.00E+05
	2,4-Dimethylphenol	105-67-9	ug/L	4.00E+00 J	1.80E+01	GP-13	2/7	N/A	Yes	4.93E+00	1.00E+05
	2-Methylnaphthalene	91-57-6	ug/L	1.40E+00	1.40E+00	UB-6	1/2	N/A	Yes	7.50E-01	1.00E+05
	Benzo(a)pyrene	50-32-8	ug/L	3.00E-01	3.00E-01	UB-6	1/2	N/A	Yes	2.00E-01	5.00E+03
	Benzo(b)fluoranthene	205-99-2	ug/L	3.00E-01	3.00E-01	UB-6	1/2	N/A	Yes	2.00E-01	4.00E+03
	Benzo(ghi)perylene	191-24-2	ug/L	2.00E-01	2.00E-01	UB-6	1/2	N/A	Yes	1.50E-01	5.00E+02
	Fluorene	86-73-7	ug/L	3.00E-01	3.00E-01	UB-6	1/2	N/A	Yes	2.00E-01	4.00E+02
	Indeno(1,2,3-cd)Pyrene	193-39-5	ug/L	4.00E-01	4.00E-01	UB-6	1/2	N/A	Yes	2.50E-01	1.00E+03
	Phenanthrene	85-01-8	ug/L	5.00E-01	5.00E-01	UB-6	1/2	N/A	Yes	3.00E-01	1.00E+05
	Phenol	108-95-2	ug/L	4.70E+01	4.70E+01	GP-13	1/7	N/A	Yes	8.86E+00	1.00E+05
	Arsenic	7440-38-2	ug/L	5.40E+01 B	5.80E+01 B	UB-6	2/2	5.50E+00	Yes	5.60E+01	9.00E+03
	Barium	7440-39-3	ug/L	2.40E+01	2.70E+01	UB-6	2/2	N/A	Yes	2.55E+01	1.00E+05
	Cadmium	7440-43-9	ug/L	1.60E-01 JB	1.70E-01 JB	UB-5	2/2	4.20E+00	No	--[2,3]	5.00E+01
	Chromium	7440-47-3	ug/L	3.70E+00 JB	3.70E+00 JB	UB-6	1/2	4.90E+00	No	--[2,3]	3.00E+03
	Iron	7439-89-6	ug/L	7.20E+03 B	9.50E+03 B	UB-5	2/2	N/A	Yes	8.35E+03	N/A
	Mercury	7439-97-6	ug/L	7.20E-02 J	7.20E-02 J	UB-5	1/2	9.50E-01	No	--[2,3]	2.00E+02
	Zinc	7440-66-6	ug/L	5.90E+00 J	2.20E+01 J	UB-5	2/2	N/A	Yes	1.40E+01	5.00E+04

Note:
[1] Background values were obtained from MADEP's Numerical Standards Spreadsheets (MADEP, 2009).
[2] If maximum detected concentration was below background value and chemical was not related to historical site activities, chemical was excluded as a COC.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
[4] MCP Method 3: UCLs in Groundwater and Soil. Retrieved August 2012, from http://www.mass.gov/dep/cleanup/laws/0996_7.htm.
COC = Chemical of Concern
FMA = Former Manufacturing Area
MADEP = Massachusetts Department of Environmental Protection
MCP = Massachusetts Contingency Plan
UCL = Upper Concentration Limits
J = Estimated value
B = Analyte detected in sample and blank
E = Exceeds calibration range
N/A - Not Available

EXHIBIT 2-8
Occurrence and Distribution of COCs in Sediment (Direct Exposure)
Reichhold, Inc., Andover, Massachusetts

Receptor:
Current/Future River Recreational Adult
Current/Future River Recreational Youth
Exposure Medium: Sediment

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Upstream Concentration[1]	COC Flag[2]	EPC Sediment[3] (mg/kg)
Sediment in Shawsheen River	1,2,4-Trimethylbenzene	95-63-6	mg/kg	1.76E+00 J	1.76E+00 J	SED2-CH12	1/2	2.50E-03 U	Yes	8.80E-01
	2-Butanone	78-93-3	mg/kg	6.70E-02	6.70E-02	SED3-CH13	1/2	1.30E-02 U	Yes	6.99E+00
	Acetone	67-64-1	mg/kg	3.15E-01	3.15E-01	SED3-CH13	1/2	3.40E-02	Yes	7.05E+00
	Carbon disulfide	75-15-0	mg/kg	3.00E-03 J	3.00E-03 J	SED3-CH13	1/2	2.50E-03 U	Yes	1.39E+00
	Chlorobenzene	108-90-7	mg/kg	1.60E-02	1.60E-02	SED3-CH13	1/2	2.50E-03 U	Yes	1.40E+00
	Ethyl ether	60-29-7	mg/kg	3.00E-03 J	3.00E-03	SED3-CH13	1/2	2.50E-03 U	Yes	1.39E+00
	Ethylbenzene	100-41-4	mg/kg	3.40E+01	3.40E+01	SED2-CH12	1/2	2.50E-03 U	Yes	1.70E+01
	Isopropylbenzene	98-82-8	mg/kg	1.59E+00 J	1.59E+00	SED2-CH12	1/2	2.50E-03 U	Yes	7.96E-01
	o-Xylene	95-47-6	mg/kg	4.93E+01	4.93E+01	SED2-CH12	1/2	2.50E-03 U	Yes	2.47E+01
	p/m-Xylene	OER-100-48	mg/kg	1.92E+02	1.92E+02	SED2-CH12	1/2	2.50E-03 U	Yes	9.61E+01
	Fluoranthene	206-44-0	mg/kg	3.25E-01 J	3.25E-01	SED2-CH12	1/2	7.10E-01 U	Yes	4.13E-01
	Arsenic	7440-38-2	mg/kg	7.80E+00	8.00E+00	SED3-CH13	2/2	9.90E+00	No	--[2,3]
	Barium	7440-39-3	mg/kg	1.80E+01	4.20E+01	SED3-CH13	2/2	1.40E+01	Yes	3.00E+01
	Cadmium	7440-43-9	mg/kg	7.30E-01	1.60E+00	SED2-CH12	2/2	2.00E-01 J	Yes	1.17E+00
	Chromium	7440-47-3	mg/kg	1.60E+01	2.10E+01	SED2-CH12	2/2	1.80E+01	Yes	1.85E+01
	Copper	7440-50-8	mg/kg	1.20E+01	2.30E+01	SED2-CH12	2/2	6.70E+00	Yes	1.75E+01
	Iron	7439-89-6	mg/kg	8.60E+03	9.30E+03	SED2-CH12	2/2	1.10E+04	No	--[2,3]
	Lead	7439-92-1	mg/kg	2.20E+01	3.20E+01	SED2-CH12	2/2	2.90E+00	Yes	2.70E+01
	Mercury	7439-97-6	mg/kg	2.30E-01	2.30E-01	SED2-CH12	1/2	1.10E-01 U	Yes	1.58E-01
	Zinc	7440-66-6	mg/kg	8.00E+01 J	1.30E+02 J	SED2-CH12	2/2	1.70E+01	Yes	1.05E+02

Note:
[1] Samples were collected upstream in the July 2007 sampling event at the Shawsheen River.
[2] If maximum detected concentration exceeded upstream value and/or was related to historical site activities, chemical was retained as a COC. Analytes were also retained as COCs if upstream concentration was non-detect.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
COC = Chemical of Concern
EPC = Exposure Point Concentration
J = Estimated value
U = Non-detect
N/A - Not Available

EXHIBIT 2-9
Occurrence and Distribution of COCs in Sediment (Fish Ingestion)
Reichhold, Inc., Andover, Massachusetts

Receptor:
Current/Future River Recreational Adult
Current/Future River Recreational Youth
Exposure Medium: Fish from Shawsheen River

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Upstream Concentration[1]	Log K_{ow}[2]	Bioaccumulative[3]	COC Flag[4]	EPC Fish Ingestion[5] (mg/kg)
Fish from Shawsheen River	1,2,4-Trimethylbenzene	95-63-6	mg/kg	1.76E+00 J	1.76E+00 J	SED2-CH12	1/2	2.50E-03 U	3.63E+00	Yes	Yes	1.12E+00
	2-Butanone	78-93-3	mg/kg	6.70E-02	6.70E-02	SED3-CH13	1/2	1.30E-02 U	2.90E-01	No	No	N/A
	Acetone	67-64-1	mg/kg	3.15E-01	3.15E-01	SED3-CH13	1/2	3.40E-02	-2.40E-01	No	No	N/A
	Carbon disulfide	75-15-0	mg/kg	3.00E-03 J	3.00E-03 J	SED3-CH13	1/2	2.50E-03 U	1.94E+00	No	No	N/A
	Chlorobenzene	108-90-7	mg/kg	1.60E-02	1.60E-02	SED3-CH13	1/2	2.50E-03 U	2.84E+00	No	No	N/A
	Ethyl ether	60-29-7	mg/kg	3.00E-03 J	3.00E-03	SED3-CH13	1/2	2.50E-03 U	8.90E-01	No	No	N/A
	Ethylbenzene	100-41-4	mg/kg	3.40E+01	3.40E+01	SED2-CH12	1/2	2.50E-03 U	3.15E+00	Yes	Yes	2.16E+01
	Isopropylbenzene	98-82-8	mg/kg	1.59E+00 J	1.59E+00	SED2-CH12	1/2	2.50E-03 U	3.66E+00	Yes	Yes	1.01E+00
	o-Xylene	95-47-6	mg/kg	4.93E+01	4.93E+01	SED2-CH12	1/2	2.50E-03 U	3.12E+00	Yes	Yes	3.13E+01
	p/m-Xylene	OER-100-48	mg/kg	1.92E+02	1.92E+02	SED2-CH12	1/2	2.50E-03 U	3.20E+00	Yes	Yes	1.22E+02
	Fluoranthene	206-44-0	mg/kg	3.25E-01 J	3.25E-01	SED2-CH12	1/2	7.10E-01 U	5.16E+00	No	No	N/A
	Arsenic	7440-38-2	mg/kg	7.80E+00	8.00E+00	SED3-CH13	2/2	9.90E+00	NA	Yes	No	N/A
	Barium	7440-39-3	mg/kg	1.80E+01	4.20E+01	SED3-CH13	2/2	1.40E+01	NA	No	No	N/A
	Cadmium	7440-43-9	mg/kg	7.30E-01	1.60E+00	SED2-CH12	2/2	2.00E-01 J	NA	Yes	Yes	5.24E-02
	Chromium	7440-47-3	mg/kg	1.60E+01	2.10E+01	SED2-CH12	2/2	1.80E+01	NA	Yes	Yes	1.99E-01
	Copper	7440-50-8	mg/kg	1.20E+01	2.30E+01	SED2-CH12	2/2	6.70E+00	NA	Yes	Yes	1.49E+00
	Iron	7439-89-6	mg/kg	8.60E+03	9.30E+03	SED2-CH12	2/2	1.10E+04	NA	No	No	N/A
	Lead	7439-92-1	mg/kg	2.20E+01	3.20E+01	SED2-CH12	2/2	2.90E+00	NA	Yes	Yes	1.08E+00
	Mercury	7439-97-6	mg/kg	2.30E-01	2.30E-01	SED2-CH12	1/2	1.10E-01 U	NA	Yes	Yes	1.38E-02
	Zinc	7440-66-6	mg/kg	8.00E+01 J	1.30E+02 J	SED2-CH12	2/2	1.70E+01	NA	Yes	Yes	3.41E+01

Note:
[1] Samples were collected upstream in the July 2007 sampling event at the Shawsheen River.
[2] Source: Oak Ridge National Laboratory (ORNL), 2012. Risk Assessment Information System. URL: http://rais.ornl.gov/cgi-bin/tools/TOX_search
[3] Organic chemicals considered bioaccumulative if log K_{ow} exceeded 3 and inorganic chemicals considered bioaccumulative according to USEPA's *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment - Status and Needs* (USEPA, 2000). According to the *Toxicological Profile for Polycyclic Aromatic Hydrocarbons* (ATSDR, 1995) and MADEP's (1995) *Guidance for Disposal Site Risk Characterization*, PAHs are readily metabolized by fish and are not expected to bioaccumulate in fish tissue.
[4] If chemical was considered bioaccumulative and maximum detected concentration exceeded upstream value and/or was related to historical site activities, chemical was retained as a COC. Analytes were also retained as COCs if upstream concentration was non-detect and analyte was bioaccumulative.
[5] EPCs are calculated on Exhibit 2-8 Supplement.
COC = Chemical of Concern
EPC = Exposure Point Concentration
J = Estimated value
K_{ow} = Octanol-Water Partition Coefficient
U = Non-detect
N/A - Not Available

EXHIBIT 2-9 Supplement
Biota-to-Sediment Accumulation Factors for COCs in Sediment
Reichhold, Inc., Andover, Massachusetts

CAS Number	COC[1]	BSAF[2] Value (unitless)	Organism Used for Deriving BSAF	BSAF Reference	Sediment EPC[4] (mg/kg)	Fish EPC[5] (mg/kg)
95-63-6	1,2,4-Trimethylbenzene	1.0E+00	--	see note[3]	8.80E-01	1.12E+00
100-41-4	Ethylbenzene	1.0E+00	--	see note[3]	1.70E+01	2.16E+01
98-82-8	Isopropylbenzene	1.0E+00	--	see note[3]	7.96E-01	1.01E+00
95-47-6	o-Xylene	1.0E+00	--	see note[3]	2.47E+01	3.13E+01
OER-100-48	p/m-Xylene	1.0E+00	--	see note[3]	9.61E+01	1.22E+02
7440-43-9	Cadmium	1.8E-01	Carnivorous, Omnivorous, and Herbivorous Fish	WDE, 1995	1.17E+00	5.24E-02
7440-47-3	Chromium	4.3E-02	Fish (Perca flavescens)	WDE, 1995	1.85E+01	1.99E-01
7440-50-8	Copper	3.4E-01	Mollusc (Elliptio complanata)	WDE, 1995	1.75E+01	1.49E+00
7439-92-1	Lead	1.6E-01	Carnivorous, Omnivorous, and Herbivorous Fish	WDE, 1995	2.70E+01	1.08E+00
7439-97-6	Mercury	3.5E-01	Fish (Available fish species)	WDE, 1995	1.58E-01	1.38E-02
7440-66-6	Zinc	1.3E+00	Carnivorous, Omnivorous, and Herbivorous Fish	WDE, 1995	1.05E+02	3.41E+01

Note:
[1] COCs are identified in Exhibit 2-8.
[2] BSAFs for metals are presented in kg-sed[dw]/kg-fish[dw]; BSAFs for organics are presented in kg-OC[dw]/kg-lipid[dw].
Although BSAF for mercury is presented in kg-sed[ww]/kg-fish[ww], it was assumed that moisture contents in sediment and fish are approximately the same (~75%).
[3] A default value of 1 was assumed if no BSAF was available.
[4] Sediment EPCs are provided in Exhibit 2-7.
[5] Fish EPCs were calculated using the following equations:

Metals: Fish EPC (mg/kg-fish [ww]) = Sed EPC (mg/kg-sed [dw]) x BSAF (kg-sed [dw]/kg-fish [dw]) x 0.25 (kg-fish [dw]/kg-fish [ww]).
Organics: Fish EPC (mg/kg-fish [ww]) = Sed EPC (mg/kg-sed [dw]) x lipid normalized BSAF (kg-OC [dw]/kg-lipid [dw]) x (%lipid / %OC) x 0.25 (kg-fish [dw]/kg-fish [ww]).
Fish EPCs were calculated assuming 0.985% organic carbon (site-specific) in sediment and 5% lipid (USEPA, 2000) and 75% moisture in fish fillet (USEPA, 1993).

COC = chemical of concern
EPC = exposure point concentration
BSAF = biota-sediment accumulation factor
OC = organic carbon
dw = dry weight basis
ww = wet weight basis

Sources:

USEPA, 1993. Wildlife exposure factors handbook. Volume I of II. EPA/600/R-93/187a

USEPA, 2000. Bioaccumulation testing and interpretation for the purpose of sediment quality assessment - status and needs. EPA/823/R-00/001.

Washington Department of Ecology (WDE), 1995. Bioaccumulation Factor Approach Analysis for Metals and Polar Organic Compounds.

EXHIBIT 2-10
Occurrence and Distribution of COCs in Surface Water
Reichhold, Inc., Andover, Massachusetts

Receptor:
Current/Future River Recreational Adult
Current/Future River Recreational Youth
Exposure Medium: Surface Water

Exposure Point	Chemical	CAS Number	Units	Minimum Detected Concentration	Maximum Detected Concentration	Location of Maximum Detected Concentration	Detection Frequency	Upstream Concentration[1]		COC Flag[2]	EPC Surface Water[3] (mg/L)
Surface Water in Shawsheen River	p/m-Xylene	OER-100-48	mg/L	1.10E+00	1.10E+00	SW2-CH12	1/2	1.00E+00	U	Yes	8.00E-04

Note:
[1] Samples were collected upstream during the July 2007 sampling event at the Shawsheen River.
[2] If maximum detected concentration exceeded upstream value and/or was related to historical site activities, chemical was retained as a COC.
[3] EPC was calculated as the mean concentration only for chemicals identified as COC.
COC = Chemical of Concern
EPC = Exposure Point Concentration
U = Non-detect

EXHIBIT 3-1
Subchronic Toxicity Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Subchronic Oral RfD (mg/kg-day)	Source for Oral RfD[1]	Subchronic Inhalation Reference Concentration (mg/m^3)	Source for Inhalation Reference Concentration[1]
1,2,4-Trimethylbenzene	95-63-6	N/A	N/A	7.00E-03	†
1,2-Dichlorobenzene	95-50-1	9.00E-01	7, 9	2.00E-01	7, 20
1,2-Dichloroethane	107-06-2	2.00E-01	7, 10	7.00E-03	†
1,3,5-Trimethylbenzene	108-67-8	1.00E-02	†	N/A	N/A
1,3-Dichlorobenzene	541-73-1	9.00E-01	7, 11	2.00E-01	7, 20
1,4-Dichlorobenzene	106-46-7	9.00E-01	7, 11	8.00E-01	†
2,4-Dichlorophenol	120-83-2	3.00E-03	7, 13	1.05E-02	7, 20
2,4-Dimethylphenol	105-67-9	2.00E-01	7, 13	7.00E-01	7, 21
2-Butanone	78-93-3	2.00E+00	13	5.00E+00	7, 22
2-Methylnaphthalene	91-57-6	4.00E-03	†	5.00E-01	7, 16
3-Methylphenol/4-Methylphenol[5]	OER-101-66	5.00E-02	12	N/A	N/A
4-Methyl-2-pentanone	108-10-1	8.00E-01	7, 13	3.00E+00	7, 20
Acetone	67-64-1	1.00E+00	13	8.00E-01	7, 20
Arsenic	7440-38-2	3.00E-04	7, 13	2.50E-06	7, 20
Barium	7440-39-3	7.00E-02	7, 13	5.00E-03	7, 23
Benzene	71-43-2	4.00E-03	†	3.00E-02	†
Benzo(a)pyrene	50-32-8	3.00E-01	7, 16	5.00E-01	7, 16
Benzo(b)fluoranthene	205-99-2	3.00E-01	7, 16	5.00E-01	7, 16
Benzo(ghi)perylene	191-24-2	3.00E-01	7, 16	5.00E-01	7, 16
bis(2-Ethylhexyl)phthalate	117-81-7	2.00E-02	7, 9	7.00E-03	7, 20
Cadmium	7440-43-9	1.00E-03	†	2.00E-05	7, 20
Carbon disulfide	75-15-0	1.00E-01	12	7.00E-01	12
Chlorobenzene	108-90-7	2.00E-01	7, 9	5.00E-02	†
Chromium[6]	7440-47-3	2.00E-02	7, 13	1.00E-04	†
Chromium III	16065-83-1	1.00E+00	7, 13	3.00E-04	7, 16
Copper	7440-50-8	4.00E-02	13	N/A	N/A
Dibenzo(a,h)anthracene	53-70-3	3.00E-01	7, 16	5.00E-01	7, 16
Dibenzofuran	132-64-9	1.00E-03	†	N/A	N/A
Ethylbenzene	100-41-4	1.00E+00	7, 9	1.00E+00	7, 22
Fluoranthene	206-44-0	4.00E-02	7, 12	5.00E-02	7, 20
Fluorene	86-73-7	4.00E-01	7, 13	5.00E-01	7, 16
Formaldehyde	50-00-0	2.00E-01	12	N/A	N/A
Hexachlorobutadiene	87-68-3	2.00E-03	7, 9	7.00E-04	7, 20
Indeno(1,2,3-cd)Pyrene	193-39-5	3.00E-01	7, 16	5.00E-01	7, 16
Iron	7439-89-6	7.00E-01	†	N/A	N/A
Isopropylbenzene	98-82-8	1.00E-01	†	4.00E-01	†
Lead	7439-92-1	7.50E-04	7, 10	1.00E-03	7, 20
Manganese	7439-96-5	1.40E-01	13	5.00E-05	12
Mercury	7439-97-6	3.00E-04	7, 12	3.00E-04	7, 20
Methyl tert butyl ether	1634-04-4	1.00E+00	15	3.00E+00	7, 20
Methylene chloride	75-09-2	6.00E-02	7, 13	3.00E+00	13
Naphthalene	91-20-3	2.00E-02	†	3.00E-03	7, 20
n-Butylbenzene	104-51-8	5.00E-02	†	N/A	N/A
n-Propylbenzene	103-65-1	1.00E-01	†	1.00E+00	†
o-Xylene[2]	95-47-6	2.00E-01	7, 12	1.00E-01	†
p/m-Xylene[2]	OER-100-48	2.00E-01	7, 12	1.00E-01	†
Phenanthrene	85-01-8	3.00E-01	7, 16	5.00E-01	7, 16
Phenol	108-95-2	3.00E-01	7, 12	2.60E-01	7, 20
p-Isopropyltoluene[3]	99-87-6	1.00E-01	†	4.00E-01	†
sec-Butylbenzene	135-98-8	N/A	N/A	N/A	N/A
Silver	7440-22-4	5.00E-03	7, 13	1.40E-04	7, 20
Styrene	100-42-5	2.00E+00	7, 9	3.00E+00	13
tert-Butylbenzene	98-06-6	N/A	N/A	N/A	N/A
Tertiary-Amyl Methyl Ether[4]	994-05-8	1.00E+00	15	3.00E+00	20
Toluene	108-88-3	8.00E-02	†	5.00E+00	†
Total Xylenes	1330-20-7	2.00E-01	7, 12	1.00E-01	†
Zinc	7440-66-6	3.00E-01	7, 13	1.40E-03	7, 20
C19-C36 Aliphatics	N/A	6.00E+00	7	N/A	N/A

Note:
[1] Applicable sources listed below, specific to the chemicals as indicated in the table.
[2] Total Xylenes was used as a surrogate for o-xylene and p/m-xylene.
[3] Isopropylbenzene was used as a surrogate for p-Isopropyltoluene.
[4] Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether.
[5] 3-methylphenol was used a surrogate for 3-methylphenol/4-methylphenol.
[6] Chromium (VI) used as a surrogate for total chromium
[7] Mass DEP. *MCP Numerical Standards Development Spreadsheets*. Retrieved August 2012, from http://www.mass.gov/dep/service/compliance/riskasmt.htm.
[9] This value has been withdrawn from HEAST
[10] Developed for the Risk Assessment ShortForm - Residential Scenario (MADEP, 2007). Documentation of this value may be found in that document.
[11] This subchronic oral RfD (from HEAST) for 1,2-Dichlorobenzene has been used as the subchronic oral RfD equivalent for 1,3- and 1,4- Dichlorobenzene.
[12] The chronic oral RfD (from IRIS) has been used here as a subchronic oral RfD equivalent.
[13] U.S. EPA Health Effects Assessment Summary Tables (HEAST), Annual FY-1997.
[15] This value was developed by MA DEP ORS Air/Water Toxics staff.
[16] Value consistent with approach "Characterizing Risks Posed by Petroleum Contaminated Sites" MA DEP 2002.
[20] Chronic value used.
[21] The subchronic RfC is set equal to a multiple (often, but not always 10) of the chronic RfC based on information about subchronic toxicity presented in the IRIS file.
[22] The subchronic RfC is set equal to the chronic RfC based on information about subchronic toxicity presented in the IRIS file.
[23] The subchronic RfC is set equal to a multiple (often, but not always 10) of the chronic RfC based on information about subchronic toxicity presented in HEAST.
† IRIS or PPRTV value obtained from USEPA Regional Screening Level table (May 2012)
N/A - Not Available
RfD - Reference Dose
IRIS - Integrated Risk Information System
PPRTV - Provisional Peer-Reviewed Toxicity Value

EXHIBIT 3-2
Chronic Toxicity Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Chronic Oral RfD (mg/kg-day)	Source for Oral RfD[1]	Chronic Inhalation Reference Concentration (mg/m^3)	Source for Inhalation Reference Concentration[1]
1,2,4-Trimethylbenzene	95-63-6	N/A	N/A	7.00E-03	†
1,2-Dichlorobenzene	95-50-1	9.00E-02	7, 9	2.00E-01	7, 19
1,2-Dichloroethane	107-06-2	6.00E-03	†	7.00E-03	†
1,3,5-Trimethylbenzene	108-67-8	1.00E-02	†	N/A	N/A
1,3-Dichlorobenzene	541-73-1	9.00E-02	7, 11	2.00E-01	7, 21
1,4-Dichlorobenzene	106-46-7	9.00E-02	7, 11	8.00E-01	7, 9
2,4-Dimethylphenol	105-67-9	2.00E-02	7, 9	7.00E-02	7, 23
2-Butanone	78-93-3	6.00E-01	7, 9	5.00E+00	7, 9
2-Methylnaphthalene	91-57-6	4.00E-03	7, 9	5.00E-02	7, 15
3-Methylphenol/4-Methylphenol[5]	OER-101-66	5.00E-02	9	N/A	N/A
4-Methyl-2-pentanone	108-10-1	8.00E-02	7, 12	3.00E+00	7
Acetone	67-64-1	9.00E-01	7, 9	8.00E-01	7, 20
Arsenic	7440-38-2	3.00E-04	7, 9	2.50E-06	7, 20
Barium	7440-39-3	2.00E-01	†	5.00E-04	7, 19
Benzene	71-43-2	4.00E-03	7, 9	3.00E-02	7, 9
bis(2-Ethylhexyl)phthalate	117-81-7	2.00E-02	7, 9	7.00E-03	7, 20
Cadmium	7440-43-9	1.00E-03	†	2.00E-05	7, 20
Carbon disulfide	75-15-0	1.00E-01	9	7.00E-01	9
Chlorobenzene	108-90-7	2.00E-02	7, 9	5.00E-02	†
Chromium[6]	7440-47-3	3.00E-03	7, 9	1.00E-04	7, 9
Chromium III	16065-83-1	1.50E+00	7, 9	N/A	N/A
Copper	7440-50-8	4.00E-02	12	N/A	N/A
Dibenzofuran	132-64-9	1.00E-03	†	N/A	N/A
Ethyl Ether	60-29-7	2.00E-01	9	N/A	N/A
Ethylbenzene	100-41-4	1.00E-01	7, 9	1.00E+00	7, 9
Fluoranthene	206-44-0	4.00E-02	7, 9	5.00E-02	7, 15
Hexachlorobutadiene	87-68-3	1.00E-03	†	7.00E-04	7, 23
Iron	7439-89-6	7.00E-01	†	N/A	N/A
Isopropylbenzene	98-82-8	1.00E-01	9	4.00E-01	9
Lead	7439-92-1	7.50E-04	7, 10	1.00E-03	7, 20
Mercury	7439-97-6	3.00E-04	7, 16	3.00E-04	7, 9
Methyl tert butyl ether	1634-04-4	1.00E-01	7, 13	3.00E+00	7, 9
Methylene chloride	75-09-2	6.00E-03	†	6.00E-01	†
Naphthalene	91-20-3	2.00E-02	7, 9	3.00E-03	7, 9
n-Butylbenzene	104-51-8	5.00E-02	†	N/A	†
n-Propylbenzene	103-65-1	1.00E-01	†	1.00E+00	†
o-Xylene[2]	95-47-6	2.00E-01	7, 9	1.00E-01	7, 9
p/m-Xylene[2]	OER-100-48	2.00E-01	7, 9	1.00E-01	7, 9
Phenanthrene	85-01-8	3.00E-02	7, 15	5.00E-02	7, 15
Phenol	108-95-2	3.00E-01	7, 9	2.60E-01	7, 20
p-Isopropyltoluene[3]	99-87-6	1.00E-01	†	4.00E-01	†
sec-Butylbenzene	135-98-8	N/A	N/A	N/A	N/A
Silver	7440-22-4	5.00E-03	7, 9	1.40E-04	7, 20
Styrene	100-42-5	2.00E-01	7, 9	1.00E+00	7, 9
tert-Butylbenzene	98-06-6	N/A	N/A	N/A	N/A
Tertiary-Amyl Methyl Ether[4]	994-05-8	1.00E-01	7, 13	3.00E+00	7, 9
Toluene	108-88-3	8.00E-02	†	5.00E+00	†
Total Xylenes	1330-20-7	2.00E-01	7, 9	1.00E-01	7, 9
Zinc	7440-66-6	3.00E-01	7, 9	1.40E-03	7, 20
C19-C36 Aliphatics	N/A	2.0E+00	7	N/A	N/A

Note:
[1] Applicable sources listed below, specific to the chemicals as indicated in the table.
[2] Total Xylenes was used as a surrogate for o-xylene and p/m-xylene.
[3] Isopropylbenzene was used as a surrogate for p-Isopropyltoluene.
[4] Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether.
[5] 3-methylphenol was used a surrogate for 3-methylphenol/4-methylphenol.
[6] Chromium (VI) used as a surrogate for total chromium
[7] Mass DEP. *MCP Numerical Standards Development Spreadsheets* . Retrieved August 2012, from http://www.mass.gov/dep/service/compliance/riskasmt.htm.
[9] U.S. EPA, Integrated Risk Information System (IRIS)
[10] Developed for the Risk Assessment ShortForm - Residential Scenario (MADEP, 2007). Documentation of this value may be found in that document.

[11] The chronic oral RfD for 1,2-Dichlorobenzene has been used as the chronic oral RfD equivalent for 1,3-Dichlorobenzene and 1,4-Dichlorobenzene.
[12] U.S. EPA Health Effects Assessment Summary Tables (HEAST), Annual FY-1997.
[13] This value was developed by MA DEP ORS Air/Water Toxics staff.
[15] Value consistent with approach presented in "Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology" MA DEP 2003 and "Characterizing Risks Posed by Petroleum Contaminated Sites" MA DEP 2002.
[16] This value has been withdrawn from HEAST
[19] IRIS lists two oral RfDs, one for food and one for water exposure. The more conservative is used here.
[20] from Table 2 of HEAST, calculated by an alternative method.
[21] CHEM/AAL
[23] Conversion of the oral Reference Dose to a Reference Concentration, using the equation: RfD x BW / Ventilation Rate
(RfD x V) /BW = (RfD x 20 m^3/day) / 70 kg
† IRIS or PPRTV value obtained from USEPA Regional Screening Level table (May 2012)
N/A - Not Available
RfD - Reference Dose
IRIS - Integrated Risk Information System
PPRTV - Provisional Peer-Reviewed Toxicity Value

EXHIBIT 3-3
Oral Slope Factors and Inhalation Unit Risk Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Oral SF (mg/kg-day)$^{-1}$	Source for Oral SF[1]	URF (ug/m^3)$^{-1}$	Source for URF[1]	Weight of Evidence
1,2,4-Trimethylbenzene	95-63-6	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	95-50-1	N/A	7	N/A	7	D
1,2-Dichloroethane	107-06-2	9.1E-02	7, 8	2.60E-05	7, 8	B2
1,3,5-Trimethylbenzene	108-67-8	N/A	N/A	N/A	N/A	N/A
1,3-Dichlorobenzene	541-73-1	N/A	7	N/A	7	D
1,4-Dichlorobenzene	106-46-7	2.4E-02	7, 9	6.86E-06	13	C
2,4-Dichlorophenol	120-83-2	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	105-67-9	N/A	N/A	N/A	N/A	N/A
2-Butanone	78-93-3	N/A	7	N/A	7	D
2-Methylnaphthalene	91-57-6	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol[5]	OER-101-66	N/A	N/A	N/A	N/A	C
4-Methyl-2-pentanone	108-10-1	N/A	N/A	N/A	N/A	N/A
Acetone	67-64-1	N/A	7	N/A	7	D
Arsenic	7440-38-2	1.5E+00	7, 8	4.30E-03	7, 8	A
Barium	7440-39-3	N/A	N/A	N/A	N/A	N/A
Benzene	71-43-2	5.5E-02	7, 8	7.80E-06	7, 8	A
Benzo(a)pyrene	50-32-8	7.3E+00	7, 8	2.09E-03	7, 13	B2
Benzo(b)fluoranthene	205-99-2	7.3E-01	7, 12	2.09E-04	7, 13	B2
Benzo(ghi)perylene	191-24-2	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	117-81-7	1.4E-02	7, 8	1.30E-06	7, 14	B2
Cadmium	7440-43-9	N/A	7	1.80E-03	7, 8	B1
Carbon disulfide	75-15-0	N/A	N/A	N/A	N/A	D
Chlorobenzene	108-90-7	N/A	7	N/A	7	D
Chromium[6]	7440-47-3	N/A	7	1.20E-02	7, 8	N/A
Chromium III	16065-83-1	N/A	N/A	N/A	N/A	D
Copper	7440-50-8	N/A	N/A	N/A	N/A	D
Dibenzo(a,h)anthracene	53-70-3	7.3E+00	7, 12	2.09E-03	7, 13	B2
Dibenzofuran	132-64-9	N/A	N/A	N/A	N/A	N/A
Ethyl Ether	60-29-7	N/A	N/A	N/A	N/A	D
Ethylbenzene	100-41-4	N/A	7	N/A	7	D
Fluoranthene	206-44-0	N/A	7	N/A	7	D
Fluorene	86-73-7	N/A	N/A	N/A	N/A	N/A
Formaldehyde	50-00-0	N/A	N/A	1.30E-05	8	B1
Hexachlorobutadiene	87-68-3	7.8E-02	7, 8	2.20E-05	7, 8	C
Indeno(1,2,3-cd)Pyrene	193-39-5	7.3E-01	7, 12	2.09E-04	7, 13	B2
Iron	7439-89-6	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	98-82-8	N/A	N/A	N/A	N/A	D
Lead	7439-92-1	N/A	7	N/A	7	B2
Manganese	7439-96-5	N/A	N/A	N/A	N/A	D
Mercury	7439-97-6	N/A	7	N/A	7	D
Methyl tert butyl ether	1634-04-4	N/A	N/A	N/A	N/A	C
Methylene chloride	75-09-2	2.0E-03	†	1.00E-08	†	B2
Naphthalene	91-20-3	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	104-51-8	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	103-65-1	N/A	N/A	N/A	N/A	N/A
o-Xylene[2]	95-47-6	N/A	7	N/A	7	D
p/m-Xylene[2]	OER-100-48	N/A	7	N/A	7	D
Phenanthrene	85-01-8	N/A	7	N/A	7	D
Phenol	108-95-2	N/A	7	N/A	7	D
p-Isopropyltoluene[3]	99-87-6	N/A	N/A	N/A	N/A	D
sec-Butylbenzene	135-98-8	N/A	N/A	N/A	N/A	N/A
Silver	7440-22-4	N/A	7	N/A	7	D
Styrene	100-42-5	3.0E-02	7, 10	5.70E-07	7, 10	B2
tert-Butylbenzene	98-06-6	N/A	N/A	N/A	N/A	N/A
Tertiary-Amyl Methyl Ether[4]	994-05-8	N/A	N/A	N/A	N/A	C
Toluene	108-88-3	N/A	7	N/A	7	D
Total Xylenes	1330-20-7	N/A	7	N/A	7	D
Zinc	7440-66-6	N/A	7	N/A	7	D
C19-C36 Aliphatics	N/A	N/A	N/A	N/A	N/A	N/A

Note:
[1] Applicable sources listed below, specific to the chemicals as indicated in the table.
[2] Total Xylenes was used as a surrogate for o-xylene and p/m-xylene.
[3] Isopropylbenzene was used as a surrogate for p-Isopropyltoluene.
[4] Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether.
[5] 3-methylphenol was used a surrogate for 3-methylphenol/4-methylphenol.
[6] Chromium (VI) used as a surrogate for total chromium

[7] Mass DEP. *MCP Numerical Standards Development Spreadsheets* . Retrieved August 2012, from http://www.mass.gov/dep/service/compliance/riskasmt.htm.
[8] U.S. EPA, Integrated Risk Information System (IRIS). On-line search.
[9] U.S. EPA Health Effects Assessment Summary Tables (HEAST), Annual FY-1997.
[10] This value has been withdrawn from HEAST
[12] This Cancer Slope Factor or Unit Risk for benzo(a)pyrene (from IRIS) has been applied to the seven PAH compounds which are designated as category A, B1, B2 or C carcinogens.
[13] Conversion of the oral Cancer Slope Factor to the inhalation Unit Risk, using the equation: Slope Factor x Ventilation Rate x Constant / Body Weight (CSF x V x C)/BW = (CSF x 20 m^3/day x 0.001 mg/µg) / 70 kg
[14] CHEM/AAL
† IRIS or PPRTV value obtained from USEPA Regional Screening Level table (May 2012)
N/A - Not Available
IRIS - Integrated Risk Information System
SF - Slope Factor
URF - Unit Risk Factor
EPA Carcinogen Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

EXHIBIT 3-4
Relative Absorption Factors
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Subchronic Exposures		Chronic Exposures		Carcinogenic Exposures	
		Soil Ingestion	Soil Dermal	Soil Ingestion	Soil Dermal	Soil Ingestion	Soil Dermal
1,2,4-Trimethylbenzene	95-63-6	0.99	0.11	0.99	0.11	N/A	N/A
1,2-Dichlorobenzene	95-50-1	1	0.1	1	0.1	N/A	N/A
1,2-Dichloroethane	107-06-2	1	0.1	1	0.1	1	0.1
1,3,5-Trimethylbenzene	108-67-8	0.99	0.11	0.99	0.11	N/A	N/A
1,3-Dichlorobenzene	541-73-1	1	0.1	1	0.1	N/A	N/A
1,4-Dichlorobenzene	106-46-7	1	0.1	1	0.1	1	0.1
2,4-Dichlorophenol	120-83-2	1	0.4	1	0.4	N/A	N/A
2,4-Dimethylphenol	105-67-9	1	0.26	1	0.26	N/A	N/A
2-Butanone	78-93-3	1	0.1	1	0.1	N/A	N/A
2-Methylnaphthalene	91-57-6	0.36	0.1	0.36	0.1	N/A	N/A
3-Methylphenol/4-Methylphenol[4]	OER-101-66	0.91	0.17	0.91	0.17	N/A	N/A
4-Methyl-2-pentanone	108-10-1	1	0.1	1	0.1	N/A	N/A
Acetone	67-64-1	1	0.1	1	0.1	N/A	N/A
Arsenic	7440-38-2	1	0.03	1	0.03	1	0.03
Barium	7440-39-3	1	0.05	1	0.05	N/A	N/A
Benzene	71-43-2	1	0.08	1	0.08	1	0.08
Benzo(a)pyrene	50-32-8	0.28	0.02	0.28	0.02	0.28	0.02
Benzo(b)fluoranthene	205-99-2	0.28	0.02	0.28	0.02	0.28	0.02
Benzo(ghi)perylene	191-24-2	0.36	0.1	0.36	0.1	N/A	N/A
bis(2-Ethylhexyl)phthalate	117-81-7	1	0.02	1	0.02	1	0.02
Cadmium	7440-43-9	1	0.14	1	0.14	N/A	N/A
Carbon disulfide	75-15-0	0.99	0.11	0.99	0.11	N/A	N/A
Chlorobenzene	108-90-7	1	0.1	1	0.1	N/A	N/A
Chromium[5]	7440-47-3	1	0.09	1	0.09	N/A	N/A
Chromium III	16065-83-1	1	0.4	1	0.4	N/A	N/A
Copper	7440-50-8	0.39	0.03	0.39	0.03	N/A	N/A
Dibenzo(a,h)anthracene	53-70-3	0.28	0.02	0.28	0.02	0.28	0.02
Dibenzofuran	132-64-9	0.91	0.17	0.91	0.17	N/A	N/A
Ethyl ether	60-29-7	0.99	0.11	0.99	0.11	N/A	N/A
Ethylbenzene	100-41-4	1	0.2	1	0.2	N/A	N/A
Fluoranthene	206-44-0	0.36	0.1	0.36	0.1	N/A	N/A
Fluorene	86-73-7	0.36	0.1	0.36	0.1	N/A	N/A
Formaldehyde	50-00-0	0.91	0.17	0.91	0.17	N/A	N/A
Hexachlorobutadiene	87-68-3	1	0.2	1	0.2	1	0.2
Indeno(1,2,3-cd)Pyrene	193-39-5	0.28	0.02	0.28	0.02	0.28	0.02
Iron	7439-89-6	0.39	0.03	0.39	0.03	N/A	N/A
Isopropylbenzene	98-82-8	0.99	0.11	0.99	0.11	N/A	N/A
Lead	7439-92-1	0.5	0.006	0.5	0.006	N/A	N/A
Manganese	7439-96-5	0.39	0.03	0.39	0.03	N/A	N/A
Mercury	7439-97-6	1	0.05	1	0.05	N/A	N/A
Methyl tert butyl ether	1634-04-4	1	0.1	1	0.1	N/A	N/A
Methylene chloride	75-09-2	1	0.1	1	0.1	1	0.1
Naphthalene	91-20-3	0.36	0.1	0.36	0.1	N/A	N/A
n-Butylbenzene	104-51-8	0.99	0.11	0.99	0.11	N/A	N/A
n-Propylbenzene	103-65-1	0.99	0.11	0.99	0.11	N/A	N/A
o-Xylene[1]	95-47-6	1	0.12	1	0.12	N/A	N/A
p/m-Xylene[1]	OER-100-48	1	0.12	1	0.12	N/A	N/A
Phenanthrene	85-01-8	0.36	0.1	0.36	0.1	N/A	N/A
Phenol	108-95-2	1	0.26	1	0.26	N/A	N/A
p-Isopropyltoluene[2]	99-87-6	0.99	0.11	0.99	0.11	N/A	N/A
sec-Butylbenzene	135-98-8	0.99	0.11	0.99	0.11	N/A	N/A
Silver	7440-22-4	1	0.25	1	0.25	N/A	N/A
Styrene	100-42-5	1	0.2	1	0.2	1	0.2
tert-Butylbenzene	98-06-6	0.99	0.11	0.99	0.11	N/A	N/A
Tertiary-Amyl Methyl Ether[3]	994-05-8	1	0.1	1	0.1	N/A	N/A
Toluene	108-88-3	1	0.12	1	0.12	N/A	N/A
Total Xylenes	1330-20-7	1	0.12	1	0.12	N/A	N/A
Zinc	7440-66-6	1	0.02	1	0.02	N/A	N/A
C19-C36 Aliphatics	N/A	1	0.1	1	0.1	N/A	N/A

Note:
[1] Total Xylenes was used as a surrogate for o-xylene and p/m-xylene.
[2] Isopropylbenzene was used as a surrogate for p-Isopropyltoluene.
[3] Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether.
[4] 3-methylphenol was used a surrogate for 3-methylphenol/4-methylphenol.
[5] Chromium (VI) used as a surrogate for total chromium
Dermal relative absorption factors for soil were also used for dermal contact with sediment, surface water, and groundwater.
N/A - Not Available (no Oral SF value)

RAFs were obtained from the Numerical Standards Spreadhseets (MADEP, Retrieved August 2012). If an RAF was not available in the Numerical Standards Spreadsheets, the default values were obtained from Appendix B-36 of the Guidance for Disposal Site Characterization (MADEP, 1995).

EXHIBIT 4-1
Exposure Factors and Assumptions
Reichhold, Inc., Andover, Massachusetts

Exposure Variable	Factor	Reference/Comments
Incidental soil ingestion, mg/day		
Onsite Recreational Adult	50	default value, > 6 years old (MADEP, 1995)
Onsite Recreational Youth [1]	50	default value, > 6 years old (MADEP, 1995)
Industrial Worker	50	default value, > 6 years old (MADEP, 1995)
Utility Worker	100	best professional judgment[3]
Construction Worker	100	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Incidental surface water ingestion, mg/day		
River Recreational Adult	50	MADEP, 1995
River Recreational Youth [1]	50	MADEP, 1995
Fish ingestion, g/day		
River Recreational Adult	32	tech guidance (MADEP, 2009b)
River Recreational Youth [1]	32	tech guidance (MADEP, 2009b)
Soil-to-skin adherence factor, mg/cm^2		
Onsite Recreational Adult	0.07	tech guidance (MADEP, 2002)
Onsite Recreational Youth [1]	0.35	tech guidance, child resident/child recreational (MADEP, 2002)
Industrial Worker	0.03	tech guidance, industrial/outdoor commercial worker (MADEP, 2002)
Utility Worker	0.29	tech guidance (MADEP, 2002)
Construction Worker	0.29	tech guidance (MADEP, 2002)
Sediment-to-skin adherence factor, mg/cm^2		
All receptors	1	tech guidance (MADEP, 2002)
Skin surface in contact with soil, cm^2		
Onsite Recreational Adult	5,781	Head, hands, forearms, and lower legs; average of male and female. (MADEP, 1995)[2]
Onsite Recreational Youth [1]	4,600	Head, hands, forearms, and lower legs; average of male and female. (MADEP, 1995)[2]
Industrial Worker	3,411	Head, hands, and forearms. (MADEP, 1995)[2]
Utility Worker	3,473	best professional judgment[3]
Construction Worker	3,473	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Skin surface in contact with surface water and sediment, cm^2		
River Recreational Adult	7,006	Head, hands, forearms, feet, and lower legs; average of male and female. (MADEP, 1995)[2]
River Recreational Youth [1]	5,467	Head, hands, forearms, feet, and lower legs; average of male and female. (MADEP, 1995)[2]
Skin surface in contact with groundwater, cm^2		
Utility Worker	3,473	best professional judgment[3, 4]
Construction Worker	3,473	MCP Numerical Standards Spreadsheets (MADEP, 2009a)[4]
Airborne particulate concentration, ug/m^3		
Onsite Recreational Adult	32	MADEP, 1995
Onsite Recreational Youth [1]	32	MADEP, 1995
Industrial Worker	32	MADEP, 1995
Utility Worker	60	best professional judgment[3,]
Construction Worker	60	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Exposure frequency soil, days/yr		
Onsite Recreational Adult	91	3 days/week, April-Oct., best professional judgment
Onsite Recreational Youth [1]	91	3 days/week, April-Oct., best professional judgment
Industrial Worker	150	5 days/week, April-Oct., best professional judgment
Utility Worker	3	best professional judgment
Construction Worker	130	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Exposure frequency surface water and sediment, days/yr		
River Recreational Adult	66	3 days/week, May-September, best professional judgment
River Recreational Youth [1]	66	3 days/week, May-September, best professional judgment
Exposure frequency groundwater, days/yr		
Utility Worker	3	best professional judgment
Construction Worker	30	best professional judgment
Exposure frequency indoor air, days/yr		
Onsite Recreational Adult	91	3 days/week, April-Oct., best professional judgment
OnsiteRecreational Youth [1]	91	3 days/week, April-Oct., best professional judgment
Industrial Worker	250	MADEP, 2011
Event Frequency surface water and sediment, event/day		
River Recreational Adult	1	best professional judgment
River Recreational Youth [1]	1	best professional judgment
Event Frequency groundwater, event/day		
Utility Worker	1	best professional judgment
Construction Worker	1	best professional judgment
Exposure time soil, hrs/day		
Onsite Recreational Adult	3	best professional judgment
Onsite Recreational Youth [1]	3	best professional judgment
Industrial Worker	8	best professional judgment
Utility Worker	8	best professional judgment
Construction Worker	8	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Exposure time surface water and sediment, hrs/day		
River Recreational Adult	1	best professional judgment
River Recreational Youth [1]	1	best professional judgment
Exposure time groundwater, hrs/day		
Utility Worker	4	best professional judgment
Construction Worker	4	best professional judgment
Exposure time indoor air, hrs/day		
Onsite Recreational Adult	3	best professional judgment
Onsite Recreational Youth [1]	3	best professional judgment
Industrial Worker	8	MADEP, 2011
Duration of event (tevent) used for calculation of DAevent, hr/event		
River Recreational Adult	1	best professional judgment
River Recreational Youth [1]	1	best professional judgment
Utility Worker	4	best professional judgment
Construction Worker	4	best professional judgment
Exposure duration, yrs		
Recreational Adult	30	MADEP, 1995
Recreational Youth [1]	11	7 to 18 years of age, best professional judgment
Industrial Worker	27	MADEP, 2011
Utility Worker	1	MADEP, 1995
Construction Worker	1	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Body weight, kg		
Recreational Adult	70	MADEP, 1995
Recreational Youth [1]	43	average of male and female, (MADEP, 1995)[2]
Industrial Worker	70	MADEP, 1995
Utility Worker	58	MCP Numerical Standards Spreadsheets (MADEP, 2009a)[3]
Construction Worker	58	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Averaging time for non-cancer, days		
Recreational Adult	10950	MADEP, 1995
Recreational Youth [1]	4015	MADEP, 1995
Industrial Worker	9855	MADEP, 2011
Utility Worker	365	MADEP, 1995
Construction Worker	182	MCP Numerical Standards Spreadsheets (MADEP, 2009a)
Averaging time for cancer, days		
All receptors	27375	MADEP, 1995
Relative Absorption Factor, %	Chemical-specific	MADEP, 1995

Note:
[1] Recreational youth is assumed to be an adolescent (7 to 18 years of age)
[2] Values presented in Appendix B of MADEP, 1995 were used to calculate receptor-specific values.
[3] Value for construction worker is assumed to be the same as value for utility worker.
[4] Surface area in contact with groundwater during excavation activities is assumed to be the same as surface area in contact with soil.

References:

Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan (MADEP, 1995).
Technical Updates – Weighted Skin-Soil Adherence Factors (MADEP, 2002).
MCP Numerical Standards Spreadsheets (MADEP, 2009a).
Technical Updates - Default Fish Ingestion Rates and Exposure Assumptions for Human Health Risk Assessments (MADEP, 2009b).
Interim Final Vapor Intrusion Guidance (MADEP, 2011).

EXHIBIT 5-1
Summary of Estimated Health Risks
Reichhold, Inc., Andover, Massachusetts

Receptor	Media	Exposure Route	ELCR	Hazard Index
Current Industrial Worker	Soil (0 - 2 ft)	Ingestion	2E-10	0.0008
		Dermal Contact	2E-11	0.0001
		Inhalation	3E-09	0.005
		Soil Total	**4E-09**	**0.006**
	Groundwater - Indoor Air[2]	Inhalation	N/A	0.000002
		Receptor Total	**4E-09**	**0.006**
Current/Future Utility Worker	Soil (0 - 6 ft)	Ingestion	2E-13	0.00007
		Dermal Contact	2E-13	0.00004
		Ingestion of Inhaled Particulates	1E-14	0.000005
		Inhalation of Particulates	4E-11	0.001
		Inhalation of Volatiles	1E-13	0.000007
		Soil Total	**5E-11**	**0.001**
	Demolished Concrete	Ingestion	N/A	0.00007
		Dermal Contact	N/A	0.00006
		Ingestion of Inhaled Particulates	N/A	0.000005
		Inhalation of Particulates	2E-12	0.0003
		Inhalation of Volatiles	N/A	0.000000002
		Concrete Total	**2E-12**	**0.0004**
	Groundwater - Excavation	Dermal Contact	2E-09	0.00006
		Inhalation	3E-11	0.002
		Groundwater Total	**2E-09**	**0.002**
		Receptor Total	**2E-09**	**0.003**
Current/Future River Recreational Adult	Sediment	Dermal Contact	N/A	0.0008
	Surface Water	Ingestion	N/A	0.00000002
		Dermal Contact	N/A	0.0000008
	Fish	Ingestion	N/A	0.2
		Receptor Total[1]	**N/A**	**0.2**
Current/Future River Recreational Youth	Sediment	Dermal Contact	N/A	0.001
	Surface Water	Ingestion	N/A	0.00000004
		Dermal Contact	N/A	0.000001
	Fish	Ingestion	N/A	0.3
		Receptor Total[1]	**N/A**	**0.3**
Future Industrial Worker	Soil (0 - 6 ft)	Ingestion	4E-07	0.007
		Dermal Contact	3E-08	0.0007
		Inhalation	6E-07	0.02
		Soil Total	**1E-06**	**0.03**
	Demolished Concrete	Ingestion	N/A	0.002
		Dermal Contact	N/A	0.0004
		Inhalation	7E-10	0.003
		Concrete Total	**7E-10**	**0.006**
	Groundwater - Indoor Air[3]	Inhalation	8E-06	13
		Receptor Total	**9E-06**	**13**
Future Construction Worker	Soil (0 - 6 ft)	Ingestion	3E-08	0.03
		Dermal Contact	1E-08	0.01
		Ingestion of Inhaled Particulates	3E-09	0.002
		Inhalation of Particulates	6E-08	0.2
		Inhalation of Volatiles	3E-10	0.03
		Soil Total	**1E-07**	**0.2**
	Demolished Concrete	Ingestion	N/A	0.006
		Dermal Contact	N/A	0.005
		Ingestion of Inhaled Particulates	N/A	0.0005
		Inhalation of Particulates	1E-10	0.02
		Inhalation of Volatiles	N/A	0.0000002
		Concrete Total	**1E-10**	**0.035**
	Groundwater - Excavation	Dermal Contact	3E-08	0.01
		Inhalation	2E-08	0.1
		Groundwater Total	**5E-08**	**0.1**
		Receptor Total	**2E-07**	**0.4**
Future Onsite Recreational Adult	Soil (0 - 2 ft)	Ingestion	5E-11	0.0002
		Dermal Contact	2E-11	0.0001
		Inhalation	9E-10	0.001
		Soil Total	**9E-10**	**0.001**
	Demolished Concrete	Ingestion	N/A	0.0005
		Dermal Contact	N/A	0.0004
		Inhalation	2E-10	0.0007
		Concrete Total	**2E-10**	**0.002**
	Groundwater - Indoor Air[2,4]	Inhalation	8E-06	13
		Receptor Total	**8E-06**	**13**
Future Onsite Recreational Youth	Soil (0 - 2 ft)	Ingestion	3E-11	0.0003
		Dermal Contact	4E-11	0.0009
		Inhalation	3E-10	0.001
		Soil Total	**4E-10**	**0.002**
	Demolished Concrete	Ingestion	N/A	0.0009
		Dermal Contact	N/A	0.002
		Inhalation	6E-11	0.0007
		Concrete Total	**6E-11**	**0.004**
	Groundwater - Indoor Air[2,4]	Inhalation	8E-06	13
		Receptor Total	**8E-06**	**13**

Note:
[1] Receptor total includes surface water, sediment and fish ingestion pathways.
[2] Only one VOC (methyl tert butyl ether) was detected in groundwater near the office and warehouse at the FMA and was at a concentration below GW-2 standard; therefore, impact on indoor air from groundwater is expected to be insignificant.
[3] Evaluation of future indoor air via vapor intrusion of VOCs from groundwater was performed semi-quantitatively due to the large uncertainties associated with the location and characteristics of future building (see text).
[4] Potential indoor air risks for an industrial worker are used to conservatively represent the potential risks for recreational receptors.
ELCR - Excess lifetime cancer risk
FMA = Former Manufacturing Area

APPENDIX A

HHRAA INTAKE/RISK CALCULATIONS (ONSITE)

Table A-1-1
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	9.7E-08	1.1E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	9.7E-08	4.5E-07	1.0E-02	4.5E-05
Acetone	9.2E-01	1.0E+00	9.8E-08	9.0E-08	9.0E-01	1.0E-07
Ethylbenzene	9.2E-01	1.0E+00	9.8E-08	9.0E-08	1.0E-01	9.0E-07
Isopropylbenzene	1.1E-01	9.9E-01	9.7E-08	1.0E-08	1.0E-01	1.0E-07
n-Butylbenzene	1.4E+00	9.9E-01	9.7E-08	1.4E-07	5.0E-02	2.7E-06
n-Propylbenzene	3.7E-01	9.9E-01	9.7E-08	3.6E-08	1.0E-01	3.6E-07
Naphthalene	1.1E+00	3.6E-01	3.5E-08	3.9E-08	2.0E-02	2.0E-06
Methyl tert butyl ether	1.9E-01	1.0E+00	9.8E-08	1.8E-08	1.0E-01	1.8E-07
Methylene chloride	7.1E-01	1.0E+00	9.8E-08	7.0E-08	6.0E-03	1.2E-05
o-Xylene	1.4E+00	1.0E+00	9.8E-08	1.3E-07	2.0E-01	6.6E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	9.7E-08	1.0E-08	1.0E-01	1.0E-07
p/m-Xylene	6.7E+00	1.0E+00	9.8E-08	6.6E-07	2.0E-01	3.3E-06
Total Xylenes	2.2E-01	1.0E+00	9.8E-08	2.2E-08	2.0E-01	1.1E-07
2,4-Dimethylphenol	1.9E-01	1.0E+00	9.8E-08	1.9E-08	2.0E-02	9.3E-07
3-Methylphenol/4-Methylphenol	2.8E-01	9.1E-01	8.9E-08	2.5E-08	5.0E-02	5.1E-07
Phenol	5.6E-01	1.0E+00	9.8E-08	5.5E-08	3.0E-01	1.8E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	9.8E-08	2.6E-08	2.0E-02	1.3E-06
Barium	2.6E+01	1.0E+00	9.8E-08	2.5E-06	2.0E-01	1.3E-05
Cadmium	1.1E+00	1.0E+00	9.8E-08	1.1E-07	1.0E-03	1.1E-04
Copper	2.2E+01	3.9E-01	3.8E-08	8.6E-07	4.0E-02	2.1E-05
Iron	1.0E+04	3.9E-01	3.8E-08	3.9E-04	7.0E-01	5.6E-04
Silver	2.9E-01	1.0E+00	9.8E-08	2.8E-08	5.0E-03	5.6E-06
Zinc	1.3E+02	1.0E+00	9.8E-08	1.3E-05	3.0E-01	4.3E-05
Hazard Index						8E-04

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-1-2
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	3.5E-08	2.5E-08	2.0E-03	5.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	3.5E-08	9.3E-09	1.4E-02	1.3E-10
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-10

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-1-3
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	2.2E-08	2.5E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	2.2E-08	1.0E-07	1.0E-02	1.0E-05
Acetone	9.2E-01	1.0E-01	2.0E-08	1.8E-08	9.0E-01	2.0E-08
Ethylbenzene	9.2E-01	2.0E-01	4.0E-08	3.7E-08	1.0E-01	3.7E-07
Isopropylbenzene	1.1E-01	1.1E-01	2.2E-08	2.4E-09	1.0E-01	2.4E-08
n-Butylbenzene	1.4E+00	1.1E-01	2.2E-08	3.1E-08	5.0E-02	6.2E-07
n-Propylbenzene	3.7E-01	1.1E-01	2.2E-08	8.3E-09	1.0E-01	8.3E-08
Naphthalene	1.1E+00	1.0E-01	2.0E-08	2.2E-08	2.0E-02	1.1E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	2.0E-08	3.7E-09	1.0E-01	3.7E-08
Methylene chloride	7.1E-01	1.0E-01	2.0E-08	1.4E-08	6.0E-03	2.4E-06
o-Xylene	1.4E+00	1.2E-01	2.4E-08	3.3E-08	2.0E-01	1.6E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	2.2E-08	2.3E-09	1.0E-01	2.3E-08
p/m-Xylene	6.7E+00	1.2E-01	2.4E-08	1.6E-07	2.0E-01	8.1E-07
Total Xylenes	2.2E-01	1.2E-01	2.4E-08	5.3E-09	2.0E-01	2.7E-08
2,4-Dimethylphenol	1.9E-01	2.6E-01	5.2E-08	9.9E-09	2.0E-02	5.0E-07
3-Methylphenol/4-Methylphenol	2.8E-01	1.7E-01	3.4E-08	9.7E-09	5.0E-02	1.9E-07
Phenol	5.6E-01	2.6E-01	5.2E-08	2.9E-08	3.0E-01	9.7E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	4.0E-09	1.1E-09	2.0E-02	5.3E-08
Barium	2.6E+01	5.0E-02	1.0E-08	2.6E-07	2.0E-01	1.3E-06
Cadmium	1.1E+00	1.4E-01	2.8E-08	3.2E-08	1.0E-03	3.2E-05
Copper	2.2E+01	3.0E-02	6.0E-09	1.3E-07	4.0E-02	3.4E-06
Iron	1.0E+04	3.0E-02	6.0E-09	6.2E-05	7.0E-01	8.9E-05
Silver	2.9E-01	2.5E-01	5.0E-08	1.4E-08	5.0E-03	2.9E-06
Zinc	1.3E+02	2.0E-02	4.0E-09	5.3E-07	3.0E-01	1.8E-06
Hazard Index						1E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-1-4
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	7.2E-09	5.1E-09	2.0E-03	1.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	1.4E-09	3.8E-10	1.4E-02	5.3E-12
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-1-5
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	1.4E-01	1.1E-05	7.0E-03	1.6E-03
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	1.4E-01	1.1E-05	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	1.4E-01	1.2E-05	8.0E-01	1.5E-05
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	1.4E-01	2.7E-05	1.0E+00	2.7E-05
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	1.4E-01	1.8E-05	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	1.4E-01	2.3E-05	1.0E+00	2.3E-05
Naphthalene	1.1E+00	5.2E+04	1.9E-05	1.4E-01	2.6E-06	3.0E-03	8.7E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	1.4E-01	3.5E-05	3.0E+00	1.2E-05
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	1.4E-01	5.8E-05	6.0E-01	9.7E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	1.4E-01	2.4E-05	1.0E-01	2.4E-04
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	1.4E-01	8.3E-10	7.0E-02	1.2E-08
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	1.4E-01	1.2E-09	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	1.4E-01	2.5E-09	2.6E-01	9.5E-09
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	1.4E-01	1.2E-09	7.0E-03	1.7E-07
Barium	2.6E+01	N/A	8.3E-07	1.4E-01	1.1E-07	5.0E-04	2.3E-04
Cadmium	1.1E+00	N/A	3.6E-08	1.4E-01	5.0E-09	2.0E-05	2.5E-04
Copper	2.2E+01	N/A	7.2E-07	1.4E-01	9.8E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	1.4E-01	4.5E-05	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	1.4E-01	1.3E-09	1.4E-04	9.0E-06
Zinc	1.3E+02	N/A	4.2E-06	1.4E-01	5.8E-07	1.4E-03	4.1E-04
Hazard Index							5E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-1-6
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	4.9E-02	4.1E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	4.9E-02	4.0E-06	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	4.9E-02	4.2E-06	N/A	N/A
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	4.9E-02	9.7E-06	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	4.9E-02	6.4E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	4.9E-02	8.2E-06	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	4.9E-02	9.4E-07	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	4.9E-02	1.3E-05	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	4.9E-02	2.1E-05	1.0E-05	2.1E-10
o-Xylene	1.4E+00	5.8E+03	1.7E-04	4.9E-02	8.6E-06	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	4.9E-02	9.4E-06	N/A	N/A
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	4.9E-02	9.4E-06	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	4.9E-02	3.0E-10	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	4.9E-02	4.5E-10	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	4.9E-02	8.8E-10	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	4.9E-02	4.2E-10	1.3E-03	5.4E-13
Barium	2.6E+01	N/A	8.3E-07	4.9E-02	4.1E-08	N/A	N/A
Cadmium	1.1E+00	N/A	3.6E-08	4.9E-02	1.8E-09	1.8E+00	3.2E-09
Copper	2.2E+01	N/A	7.2E-07	4.9E-02	3.5E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	4.9E-02	1.6E-05	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	4.9E-02	4.5E-10	N/A	N/A
Zinc	1.3E+02	N/A	4.2E-06	4.9E-02	2.1E-07	N/A	N/A
Cancer Risk							3E-09

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

VF = Volatilization Factor

Table A-2-1
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	9.9E-01	4.7E-09	1.1E-09	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	9.9E-01	4.7E-09	6.1E-10	1.0E-02	6.1E-08
1,4-Dichlorobenzene	1.2E-01	1.0E+00	4.7E-09	5.5E-10	9.0E-01	6.1E-10
2-Butanone	3.4E-01	1.0E+00	4.7E-09	1.6E-09	2.0E+00	8.0E-10
Acetone	3.5E-01	1.0E+00	4.7E-09	1.7E-09	1.0E+00	1.7E-09
Carbon disulfide	1.9E-01	9.9E-01	4.7E-09	9.1E-10	1.0E-01	9.1E-09
Chlorobenzene	5.8E-02	1.0E+00	4.7E-09	2.7E-10	2.0E-01	1.4E-09
Ethylbenzene	1.4E+00	1.0E+00	4.7E-09	6.6E-09	1.0E+00	6.6E-09
n-Propylbenzene	5.1E-02	9.9E-01	4.7E-09	2.4E-10	1.0E-01	2.4E-09
Naphthalene	1.2E-01	3.6E-01	1.7E-09	2.0E-10	2.0E-02	1.0E-08
o-Xylene	2.1E+00	1.0E+00	4.7E-09	9.8E-09	2.0E-01	4.9E-08
p/m-Xylene	9.9E+00	1.0E+00	4.7E-09	4.7E-08	2.0E-01	2.3E-07
Total Xylenes	7.5E+00	1.0E+00	4.7E-09	3.6E-08	2.0E-01	1.8E-07
2,4-Dimethylphenol	3.1E-01	1.0E+00	4.7E-09	1.5E-09	2.0E-01	7.3E-09
3-Methylphenol/4-Methylphenol	4.9E-01	9.1E-01	4.3E-09	2.1E-09	5.0E-02	4.2E-08
Phenol	7.9E-01	1.0E+00	4.7E-09	3.7E-09	3.0E-01	1.2E-08
Cadmium	4.4E+00	1.0E+00	4.7E-09	2.1E-08	1.0E-03	2.1E-05
Zinc	3.0E+03	1.0E+00	4.7E-09	1.4E-05	3.0E-01	4.7E-05
Hazard Index						7E-05

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-2
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	2.4E-01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.0E+00	6.3E-11	7.4E-12	2.4E-02	1.8E-13
2-Butanone	3.4E-01	N/A	N/A	N/A	N/A	N/A
Acetone	3.5E-01	N/A	N/A	N/A	N/A	N/A
Carbon disulfide	1.9E-01	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	5.8E-02	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	5.1E-02	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.2E-01	N/A	N/A	N/A	N/A	N/A
o-Xylene	2.1E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	9.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	7.5E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	3.1E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	4.9E-01	N/A	N/A	N/A	N/A	N/A
Phenol	7.9E-01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.4E+00	N/A	N/A	N/A	N/A	N/A
Zinc	3.0E+03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-13

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-3
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	1.1E-01	5.2E-09	1.3E-09	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	1.1E-01	5.2E-09	6.8E-10	1.0E-02	6.8E-08
1,4-Dichlorobenzene	1.2E-01	1.0E-01	4.8E-09	5.6E-10	9.0E-01	6.2E-10
2-Butanone	3.4E-01	1.0E-01	4.8E-09	1.6E-09	2.0E+00	8.1E-10
Acetone	3.5E-01	1.0E-01	4.8E-09	1.7E-09	1.0E+00	1.7E-09
Carbon disulfide	1.9E-01	1.1E-01	5.2E-09	1.0E-09	1.0E-01	1.0E-08
Chlorobenzene	5.8E-02	1.0E-01	4.8E-09	2.8E-10	2.0E-01	1.4E-09
Ethylbenzene	1.4E+00	2.0E-01	9.5E-09	1.3E-08	1.0E+00	1.3E-08
n-Propylbenzene	5.1E-02	1.1E-01	5.2E-09	2.7E-10	1.0E-01	2.7E-09
Naphthalene	1.2E-01	1.0E-01	4.8E-09	5.6E-10	2.0E-02	2.8E-08
o-Xylene	2.1E+00	1.2E-01	5.7E-09	1.2E-08	2.0E-01	5.9E-08
p/m-Xylene	9.9E+00	1.2E-01	5.7E-09	5.6E-08	2.0E-01	2.8E-07
Total Xylenes	7.5E+00	1.2E-01	5.7E-09	4.3E-08	2.0E-01	2.2E-07
2,4-Dimethylphenol	3.1E-01	2.6E-01	1.2E-08	3.8E-09	2.0E-01	1.9E-08
3-Methylphenol/4-Methylphenol	4.9E-01	1.7E-01	8.1E-09	4.0E-09	5.0E-02	8.0E-08
Phenol	7.9E-01	2.6E-01	1.2E-08	9.7E-09	3.0E-01	3.2E-08
Cadmium	4.4E+00	1.4E-01	6.7E-09	2.9E-08	1.0E-03	2.9E-05
Zinc	3.0E+03	2.0E-02	9.5E-10	2.9E-06	3.0E-01	9.6E-06
Hazard Index						4E-05

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD
Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-4
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	2.4E-01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.0E-01	6.3E-11	7.4E-12	2.4E-02	1.8E-13
2-Butanone	3.4E-01	N/A	N/A	N/A	N/A	N/A
Acetone	3.5E-01	N/A	N/A	N/A	N/A	N/A
Carbon disulfide	1.9E-01	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	5.8E-02	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	5.1E-02	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.2E-01	N/A	N/A	N/A	N/A	N/A
o-Xylene	2.1E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	9.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	7.5E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	3.1E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	4.9E-01	N/A	N/A	N/A	N/A	N/A
Phenol	7.9E-01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.4E+00	N/A	N/A	N/A	N/A	N/A
Zinc	3.0E+03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-13

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-5
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Ingestion of Inhaled Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	9.9E-01	2.2E-08	4.0E-03	8.8E-11	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	9.9E-01	1.2E-08	4.0E-03	4.7E-11	1.0E-02	4.7E-09
1,4-Dichlorobenzene	1.2E-01	1.0E+00	1.1E-08	4.1E-03	4.3E-11	9.0E-01	4.8E-11
2-Butanone	3.4E-01	1.0E+00	3.0E-08	4.1E-03	1.2E-10	2.0E+00	6.2E-11
Acetone	3.5E-01	1.0E+00	3.2E-08	4.1E-03	1.3E-10	1.0E+00	1.3E-10
Carbon disulfide	1.9E-01	9.9E-01	1.7E-08	4.0E-03	7.1E-11	1.0E-01	7.1E-10
Chlorobenzene	5.8E-02	1.0E+00	5.2E-09	4.1E-03	2.1E-11	2.0E-01	1.1E-10
Ethylbenzene	1.4E+00	1.0E+00	1.3E-07	4.1E-03	5.1E-10	1.0E+00	5.1E-10
n-Propylbenzene	5.1E-02	9.9E-01	4.6E-09	4.0E-03	1.9E-11	1.0E-01	1.9E-10
Naphthalene	1.2E-01	3.6E-01	1.1E-08	1.5E-03	1.5E-11	2.0E-02	7.7E-10
o-Xylene	2.1E+00	1.0E+00	1.9E-07	4.1E-03	7.6E-10	2.0E-01	3.8E-09
p/m-Xylene	9.9E+00	1.0E+00	8.9E-07	4.1E-03	3.6E-09	2.0E-01	1.8E-08
Total Xylenes	7.5E+00	1.0E+00	6.8E-07	4.1E-03	2.8E-09	2.0E-01	1.4E-08
2,4-Dimethylphenol	3.1E-01	1.0E+00	2.8E-08	4.1E-03	1.1E-10	2.0E-01	5.6E-10
3-Methylphenol/4-Methylphenol	4.9E-01	9.1E-01	4.4E-08	3.7E-03	1.7E-10	5.0E-02	3.3E-09
Phenol	7.9E-01	1.0E+00	7.1E-08	4.1E-03	2.9E-10	3.0E-01	9.6E-10
Cadmium	4.4E+00	1.0E+00	3.9E-07	4.1E-03	1.6E-09	1.0E-03	1.6E-06
Zinc	3.0E+03	1.0E+00	2.7E-04	4.1E-03	1.1E-06	3.0E-01	3.7E-06
Hazard Index							5E-06

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-6
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Ingestion of Inhaled Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	2.43E-01	N/A	2.19E-08	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	1.30E-01	N/A	1.17E-08	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.17E-01	1.00E+00	1.05E-08	5.44E-05	5.73E-13	2.40E-02	1.4E-14
2-Butanone	3.38E-01	N/A	3.05E-08	N/A	N/A	N/A	N/A
Acetone	3.54E-01	N/A	3.18E-08	N/A	N/A	N/A	N/A
Carbon disulfide	1.94E-01	N/A	1.75E-08	N/A	N/A	N/A	N/A
Chlorobenzene	5.81E-02	N/A	5.23E-09	N/A	N/A	N/A	N/A
Ethylbenzene	1.40E+00	N/A	1.26E-07	N/A	N/A	N/A	N/A
n-Propylbenzene	5.11E-02	N/A	4.60E-09	N/A	N/A	N/A	N/A
Naphthalene	1.17E-01	N/A	1.05E-08	N/A	N/A	N/A	N/A
o-Xylene	2.06E+00	N/A	1.86E-07	N/A	N/A	N/A	N/A
p/m-Xylene	9.89E+00	N/A	8.90E-07	N/A	N/A	N/A	N/A
Total Xylenes	7.55E+00	N/A	6.79E-07	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	3.07E-01	N/A	2.77E-08	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	4.94E-01	N/A	4.45E-08	N/A	N/A	N/A	N/A
Phenol	7.85E-01	N/A	7.07E-08	N/A	N/A	N/A	N/A
Cadmium	4.36E+00	N/A	3.92E-07	N/A	N/A	N/A	N/A
Zinc	3.02E+03	N/A	2.71E-04	N/A	N/A	N/A	N/A
Cancer Risk							1E-14

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-7
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	RfC (mg/m^3)	RFD_{inhal} (mg/kg/day)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	1.0E+00	7.3E-09	4.1E-03	3.0E-11	7.0E-03	2.0E-03	1.5E-08
1,3,5-Trimethylbenzene	1.3E-01	1.0E+00	3.9E-09	4.1E-03	1.6E-11	N/A	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.0E+00	3.5E-09	4.1E-03	1.4E-11	8.0E-01	2.3E-01	6.3E-11
2-Butanone	3.4E-01	1.0E+00	1.0E-08	4.1E-03	4.1E-11	5.0E+00	1.4E+00	2.9E-11
Acetone	3.5E-01	1.0E+00	1.1E-08	4.1E-03	4.3E-11	8.0E-01	2.3E-01	1.9E-10
Carbon disulfide	1.9E-01	1.0E+00	5.8E-09	4.1E-03	2.4E-11	7.0E-01	2.0E-01	1.2E-10
Chlorobenzene	5.8E-02	1.0E+00	1.7E-09	4.1E-03	7.1E-12	5.0E-02	1.4E-02	5.0E-10
Ethylbenzene	1.4E+00	1.0E+00	4.2E-08	4.1E-03	1.7E-10	1.0E+00	2.9E-01	6.0E-10
n-Propylbenzene	5.1E-02	1.0E+00	1.5E-09	4.1E-03	6.3E-12	1.0E+00	2.9E-01	2.2E-11
Naphthalene	1.2E-01	1.0E+00	3.5E-09	4.1E-03	1.4E-11	3.0E-03	8.6E-04	1.7E-08
o-Xylene	2.1E+00	1.0E+00	6.2E-08	4.1E-03	2.5E-10	1.0E-01	2.9E-02	8.8E-09
p/m-Xylene	9.9E+00	1.0E+00	3.0E-07	4.1E-03	1.2E-09	1.0E-01	2.9E-02	4.2E-08
Total Xylenes	7.5E+00	1.0E+00	2.3E-07	4.1E-03	9.2E-10	1.0E-01	2.9E-02	3.2E-08
2,4-Dimethylphenol	3.1E-01	1.0E+00	9.2E-09	4.1E-03	3.8E-11	7.0E-01	2.0E-01	1.9E-10
3-Methylphenol/4-Methylphenol	4.9E-01	1.0E+00	1.5E-08	4.1E-03	6.1E-11	N/A	N/A	N/A
Phenol	7.9E-01	1.0E+00	2.4E-08	4.1E-03	9.6E-11	2.6E-01	7.4E-02	1.3E-09
Cadmium	4.4E+00	1.0E+00	1.3E-07	4.1E-03	5.3E-10	2.0E-05	5.7E-06	9.3E-05
Zinc	3.0E+03	1.0E+00	9.0E-05	4.1E-03	3.7E-07	1.4E-03	4.0E-04	9.2E-04
Hazard Index								1E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION

RfD_{inhal} = [RfC *INH (20 m^3/day)] / BW (70 kg)

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-2-8
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	Unit Risk $(mg/m^3)^{-1}$	CSF_{inhal} (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	2.4E-01	1.0E+00	7.3E-09	5.4E-05	4.0E-13	N/A	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	1.0E+00	3.9E-09	5.4E-05	2.1E-13	N/A	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.0E+00	3.5E-09	5.4E-05	1.9E-13	6.9E-03	2.4E-02	4.6E-15
2-Butanone	3.4E-01	1.0E+00	1.0E-08	5.4E-05	5.5E-13	N/A	N/A	N/A
Acetone	3.5E-01	1.0E+00	1.1E-08	5.4E-05	5.8E-13	N/A	N/A	N/A
Carbon disulfide	1.9E-01	1.0E+00	5.8E-09	5.4E-05	3.2E-13	N/A	N/A	N/A
Chlorobenzene	5.8E-02	1.0E+00	1.7E-09	5.4E-05	9.5E-14	N/A	N/A	N/A
Ethylbenzene	1.4E+00	1.0E+00	4.2E-08	5.4E-05	2.3E-12	N/A	N/A	N/A
n-Propylbenzene	5.1E-02	1.0E+00	1.5E-09	5.4E-05	8.3E-14	N/A	N/A	N/A
Naphthalene	1.2E-01	1.0E+00	3.5E-09	5.4E-05	1.9E-13	N/A	N/A	N/A
o-Xylene	2.1E+00	1.0E+00	6.2E-08	5.4E-05	3.4E-12	N/A	N/A	N/A
p/m-Xylene	9.9E+00	1.0E+00	3.0E-07	5.4E-05	1.6E-11	N/A	N/A	N/A
Total Xylenes	7.5E+00	1.0E+00	2.3E-07	5.4E-05	1.2E-11	N/A	N/A	N/A
2,4-Dimethylphenol	3.1E-01	1.0E+00	9.2E-09	5.4E-05	5.0E-13	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	4.9E-01	1.0E+00	1.5E-08	5.4E-05	8.1E-13	N/A	N/A	N/A
Phenol	7.9E-01	1.0E+00	2.4E-08	5.4E-05	1.3E-12	N/A	N/A	N/A
Cadmium	4.4E+00	1.0E+00	1.3E-07	5.4E-05	7.1E-12	1.8E+00	6.3E+00	4.5E-11
Zinc	3.0E+03	1.0E+00	9.0E-05	5.4E-05	4.9E-09	N/A	N/A	N/A
Cancer Risk								4E-11

EXPOSURE ASSUMPTIONS		
Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION
CSF_{inhal} = [CSF_{oral} * BW (70 kg)] / INH (20 m^3/day)

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-2-9
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	1.2E+04	1.2E-06	2.7E-03	3.3E-09	7.0E-03	4.8E-07
1,3,5-Trimethylbenzene	1.3E-01	1.2E+04	6.4E-07	2.7E-03	1.7E-09	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.2E+04	5.8E-07	2.7E-03	1.6E-09	8.0E-01	2.0E-09
2-Butanone	3.4E-01	1.3E+04	1.6E-06	2.7E-03	4.4E-09	5.0E+00	8.7E-10
Acetone	3.5E-01	1.2E+04	1.8E-06	2.7E-03	4.9E-09	8.0E-01	6.2E-09
Carbon disulfide	1.9E-01	1.1E+03	1.0E-05	2.7E-03	2.9E-08	7.0E-01	4.1E-08
Chlorobenzene	5.8E-02	5.9E+03	5.9E-07	2.7E-03	1.6E-09	5.0E-02	3.3E-08
Ethylbenzene	1.4E+00	5.1E+03	1.7E-05	2.7E-03	4.5E-08	1.0E+00	4.5E-08
n-Propylbenzene	5.1E-02	6.0E+03	5.1E-07	2.7E-03	1.4E-09	1.0E+00	1.4E-09
Naphthalene	1.2E-01	5.2E+04	1.3E-07	2.7E-03	3.7E-10	3.0E-03	1.2E-07
o-Xylene	2.1E+00	5.8E+03	2.1E-05	2.7E-03	5.9E-08	1.0E-01	5.9E-07
p/m-Xylene	9.9E+00	5.2E+03	1.1E-04	2.7E-03	3.1E-07	1.0E-01	3.1E-06
Total Xylenes	7.5E+00	5.2E+03	8.6E-05	2.7E-03	2.4E-07	1.0E-01	2.4E-06
Hazard Index							7E-06

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

VF = Volatilization Factor

Table A-2-10
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	2.4E-01	1.2E+04	1.2E-06	3.7E-05	4.4E-11	N/A	N/A
1,3,5-Trimethylbenzene	1.3E-01	1.2E+04	6.4E-07	3.7E-05	2.3E-11	N/A	N/A
1,4-Dichlorobenzene	1.2E-01	1.2E+04	5.8E-07	3.7E-05	2.1E-11	6.9E-03	1.4E-13
2-Butanone	3.4E-01	1.3E+04	1.6E-06	3.7E-05	5.8E-11	N/A	N/A
Acetone	3.5E-01	1.2E+04	1.8E-06	3.7E-05	6.6E-11	N/A	N/A
Carbon disulfide	1.9E-01	1.1E+03	1.0E-05	3.7E-05	3.8E-10	N/A	N/A
Chlorobenzene	5.8E-02	5.9E+03	5.9E-07	3.7E-05	2.2E-11	N/A	N/A
Ethylbenzene	1.4E+00	5.1E+03	1.7E-05	3.7E-05	6.1E-10	N/A	N/A
n-Propylbenzene	5.1E-02	6.0E+03	5.1E-07	3.7E-05	1.9E-11	N/A	N/A
Naphthalene	1.2E-01	5.2E+04	1.3E-07	3.7E-05	4.9E-12	N/A	N/A
o-Xylene	2.1E+00	5.8E+03	2.1E-05	3.7E-05	7.8E-10	N/A	N/A
p/m-Xylene	9.9E+00	5.2E+03	1.1E-04	3.7E-05	4.1E-09	N/A	N/A
Total Xylenes	7.5E+00	5.2E+03	8.6E-05	3.7E-05	3.2E-09	N/A	N/A
2,4-Dimethylphenol	3.1E-01	N/A	N/A	3.7E-05	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	4.9E-01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Phenol	7.9E-01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Cadmium	4.4E+00	N/A	N/A	3.7E-05	N/A	1.8E+00	N/A
Zinc	3.0E+03	N/A	N/A	3.7E-05	N/A	N/A	N/A
Cancer Risk							1E-13

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-2-11
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Groundwater Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	DAevent (mg/cm^2-event)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	2.4E-01	1.1E-01	8.7E-05	5.4E-02	4.7E-06	N/A	N/A
1,2-Dichlorobenzene	2.6E-03	1.0E-01	5.4E-07	4.9E-02	2.7E-08	9.0E-01	2.9E-08
1,3,5-Trimethylbenzene	1.2E-02	1.1E-01	3.4E-06	5.4E-02	1.8E-07	1.0E-02	1.8E-05
1,3-Dichlorobenzene	1.2E-03	1.0E-01	3.4E-07	4.9E-02	1.7E-08	9.0E-01	1.9E-08
1,4-Dichlorobenzene	3.9E-03	1.0E-01	8.3E-07	4.9E-02	4.1E-08	9.0E-01	4.5E-08
4-Methyl-2-pentanone	1.1E-01	1.0E-01	1.4E-06	4.9E-02	7.0E-08	8.0E-01	8.8E-08
Acetone	1.2E-02	1.0E-01	2.7E-08	4.9E-02	1.3E-09	1.0E+00	1.3E-09
Benzene	1.3E-03	8.0E-02	8.5E-08	3.9E-02	3.4E-09	4.0E-03	8.4E-07
Chlorobenzene	1.6E-02	1.0E-01	2.0E-06	4.9E-02	1.0E-07	2.0E-01	5.0E-07
Ethylbenzene	9.3E-03	2.0E-01	2.0E-06	9.8E-02	2.0E-07	1.0E+00	2.0E-07
Isopropylbenzene	1.6E-02	1.1E-01	4.6E-06	5.4E-02	2.5E-07	1.0E-01	2.5E-06
Methyl tert butyl ether	1.6E-03	1.0E-01	1.6E-08	4.9E-02	7.9E-10	1.0E+00	7.9E-10
Naphthalene	1.1E-02	1.0E-01	2.4E-06	4.9E-02	1.2E-07	2.0E-02	6.0E-06
n-Butylbenzene	8.2E-03	1.1E-01	7.3E-06	5.4E-02	4.0E-07	5.0E-02	7.9E-06
n-Propylbenzene	1.8E-02	1.1E-01	6.9E-06	5.4E-02	3.7E-07	1.0E-01	3.7E-06
o-Xylene	1.5E-02	1.2E-01	3.0E-06	5.9E-02	1.8E-07	2.0E-01	8.9E-07
p/m-Xylene	1.1E-01	1.2E-01	2.6E-05	5.9E-02	1.5E-06	2.0E-01	7.6E-06
p-Isopropyltoluene	1.3E-03	1.1E-01	7.8E-07	5.4E-02	4.2E-08	1.0E-01	4.2E-07
Toluene	3.9E-03	1.2E-01	5.2E-07	5.9E-02	3.1E-08	8.0E-02	3.9E-07
2,4-Dimethylphenol	4.9E-03	2.6E-01	2.6E-07	1.3E-01	3.4E-08	2.0E-01	1.7E-07
2-Methylnaphthalene	7.5E-04	1.0E-01	2.6E-07	4.9E-02	1.3E-08	4.0E-03	3.2E-06
Benzo(a)pyrene	2.0E-04	2.0E-02	1.3E-06	9.8E-03	1.3E-08	3.0E-01	4.2E-08
Benzo(b)fluoranthene	2.0E-04	2.0E-02	1.3E-06	9.8E-03	1.3E-08	3.0E-01	4.2E-08
Benzo(ghi)perylene	1.5E-04	1.0E-01	1.9E-06	4.9E-02	9.4E-08	3.0E-01	3.1E-07
Fluorene	2.0E-04	1.0E-01	9.8E-09	4.9E-02	4.8E-10	4.0E-01	1.2E-09
Indeno(1,2,3-cd)Pyrene	2.5E-04	2.0E-02	1.7E-06	9.8E-03	1.7E-08	3.0E-01	5.5E-08
Phenanthrene	3.0E-04	1.0E-01	2.5E-07	4.9E-02	1.2E-08	3.0E-01	4.0E-08
Phenol	8.9E-03	2.6E-01	1.8E-07	1.3E-01	2.3E-08	3.0E-01	7.6E-08
Arsenic	5.6E-02	3.0E-02	2.2E-07	1.5E-02	3.3E-09	3.0E-04	1.1E-05
Barium	2.6E-02	5.0E-02	1.0E-07	2.5E-02	2.5E-09	7.0E-02	3.6E-08
Iron	8.4E+00	3.0E-02	3.3E-05	1.5E-02	4.9E-07	7.0E-01	7.0E-07
Zinc	1.4E-02	2.0E-02	3.3E-08	9.8E-03	3.3E-10	3.0E-01	1.1E-09
Hazard Index							6E-05

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Event Frequency (EV)	1	(event/day)
Exposure Frequency (EF)	3	(days/year)
Event Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = DAD / RfD

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-2-12
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Groundwater Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	DAevent (mg/cm^2-event)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	SF oral $(mg/kg\text{-}day)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	2.4E-01	N/A	8.7E-05	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.6E-03	N/A	5.4E-07	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	1.2E-02	N/A	3.4E-06	N/A	N/A	N/A	N/A
1,3-Dichlorobenzene	1.2E-03	N/A	3.4E-07	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	3.9E-03	1.0E-01	8.3E-07	6.6E-04	5.4E-10	2.4E-02	1.3E-11
4-Methyl-2-pentanone	1.1E-01	N/A	1.4E-06	N/A	N/A	N/A	N/A
Acetone	1.2E-02	N/A	2.7E-08	N/A	N/A	N/A	N/A
Benzene	1.3E-03	8.0E-02	8.5E-08	5.2E-04	4.5E-11	5.5E-02	2.5E-12
Chlorobenzene	1.6E-02	N/A	2.0E-06	N/A	N/A	N/A	N/A
Ethylbenzene	9.3E-03	N/A	2.0E-06	N/A	N/A	N/A	N/A
Isopropylbenzene	1.6E-02	N/A	4.6E-06	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.6E-03	N/A	1.6E-08	N/A	N/A	N/A	N/A
Naphthalene	1.1E-02	N/A	2.4E-06	N/A	N/A	N/A	N/A
n-Butylbenzene	8.2E-03	N/A	7.3E-06	N/A	N/A	N/A	N/A
n-Propylbenzene	1.8E-02	N/A	6.9E-06	N/A	N/A	N/A	N/A
o-Xylene	1.5E-02	N/A	3.0E-06	N/A	N/A	N/A	N/A
p/m-Xylene	1.1E-01	N/A	2.6E-05	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.3E-03	N/A	7.8E-07	N/A	N/A	N/A	N/A
Toluene	3.9E-03	N/A	5.2E-07	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.9E-03	N/A	2.6E-07	N/A	N/A	N/A	N/A
2-Methylnaphthalene	7.5E-04	N/A	2.6E-07	N/A	N/A	N/A	N/A
Benzo(a)pyrene	2.0E-04	2.0E-02	1.3E-06	1.3E-04	1.7E-10	7.3E+00	1.2E-09
Benzo(b)fluoranthene	2.0E-04	2.0E-02	1.3E-06	1.3E-04	1.7E-10	7.3E-01	1.2E-10
Benzo(ghi)perylene	1.5E-04	N/A	1.9E-06	N/A	N/A	N/A	N/A
Fluorene	2.0E-04	N/A	9.8E-09	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)Pyrene	2.5E-04	2.0E-02	1.7E-06	1.3E-04	2.2E-10	7.3E-01	1.6E-10
Phenanthrene	3.0E-04	N/A	2.5E-07	N/A	N/A	N/A	N/A
Phenol	8.9E-03	N/A	1.8E-07	N/A	N/A	N/A	N/A
Arsenic	5.6E-02	3.0E-02	2.2E-07	2.0E-04	4.4E-11	1.5E+00	6.6E-11
Barium	2.6E-02	N/A	1.0E-07	N/A	N/A	N/A	N/A
Iron	8.4E+00	N/A	3.3E-05	N/A	N/A	N/A	N/A
Zinc	1.4E-02	N/A	3.3E-08	N/A	N/A	N/A	N/A
Cancer Risk							2E-09

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Event Frequency (EV)	1	(event/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = DAD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-12.Supplement A
Current Land Use Scenario (Former Manufacturing Area) - Utility Worker
Groundwater Dermal Contact
Reichhold, Inc., Andover, Massachusetts

Chemical of Potential Concern	Groundwater Concentration (CW) (ug/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
1,2,4-Trimethylbenzene	2.43E+02	8.4E-02	3.5E-01	5.0E-01	1.2E+00	1.0E+00	4.0	8.7E-05	3
1,2-Dichlorobenzene	2.59E+00	4.1E-02	1.9E-01	7.1E-01	1.7E+00	1.0E+00	4.0	5.4E-07	3
1,3,5-Trimethylbenzene	1.25E+01	6.1E-02	2.6E-01	5.0E-01	1.2E+00	1.0E+00	4.0	3.4E-06	3
1,3-Dichlorobenzene	1.20E+00	5.8E-02	2.7E-01	7.1E-01	1.7E+00	1.0E+00	4.0	3.4E-07	3
1,4-Dichlorobenzene	3.91E+00	4.2E-02	2.0E-01	7.1E-01	1.7E+00	1.0E+00	4.0	8.3E-07	3
4-Methyl-2-pentanone	1.14E+02	2.7E-03	1.0E-02	3.9E-01	9.3E-01	1.0E+00	4.0	1.4E-06	3
Acetone	1.15E+01	5.2E-04	1.5E-03	2.2E-01	5.3E-01	1.0E+00	4.0	2.7E-08	3
Benzene	1.30E+00	1.5E-02	5.1E-02	2.9E-01	7.0E-01	1.0E+00	4.0	8.5E-08	3
Chlorobenzene	1.56E+01	2.8E-02	1.2E-01	4.6E-01	1.1E+00	1.0E+00	4.0	2.0E-06	3
Ethylbenzene	9.26E+00	4.9E-02	2.0E-01	4.2E-01	1.0E+00	1.0E+00	4.0	2.0E-06	3
Isopropylbenzene	1.64E+01	6.4E-02	2.7E-01	4.9E-01	1.2E+00	1.0E+00	4.0	4.6E-06	3
Methyl tert butyl ether	1.64E+00	2.1E-03	7.7E-03	3.3E-01	7.9E-01	1.0E+00	4.0	1.6E-08	3
Naphthalene	1.12E+01	4.7E-02	2.0E-01	5.6E-01	1.3E+00	1.0E+00	4.0	2.4E-06	3
n-Butylbenzene	8.21E+00	2.2E-01	9.7E-01	5.9E-01	2.3E+00	1.0E+00	4.0	7.3E-06	3
n-Propylbenzene	1.78E+01	9.2E-02	3.9E-01	5.0E-01	1.2E+00	1.0E+00	4.0	6.9E-06	3
o-Xylene	1.48E+01	4.7E-02	1.9E-01	4.1E-01	9.9E-01	1.0E+00	4.0	3.0E-06	3
p/m-Xylene	1.14E+02	5.2E-02	2.1E-01	4.1E-01	9.9E-01	1.0E+00	4.0	2.6E-05	3
p-Isopropyltoluene	1.29E+00	1.4E-01	6.4E-01	5.9E-01	2.4E+00	1.0E+00	4.0	7.8E-07	3
Toluene	3.86E+00	3.1E-02	1.1E-01	3.5E-01	8.4E-01	1.0E+00	4.0	5.2E-07	3
2,4-Dimethylphenol	4.93E+00	1.1E-02	4.6E-02	5.2E-01	1.2E+00	1.0E+00	4.0	2.6E-07	3
2-Methylnaphthalene	7.50E-01	7.2E-02	3.3E-01	6.6E-01	1.6E+00	1.0E+00	4.0	2.6E-07	3
Benzo(a)pyrene	2.00E-01	7.0E-01	4.3E+00	2.7E+00	1.2E+01	1.0E+00	4.0	1.3E-06	2
Benzo(b)fluoranthene	2.00E-01	7.0E-01	4.3E+00	2.8E+00	1.2E+01	1.0E+00	4.0	1.3E-06	2
Benzo(ghi)perylene	1.50E-01	1.2E+00	7.6E+00	3.7E+00	1.7E+01	1.0E+00	4.0	1.9E-06	2
Fluorene	2.00E-01	7.8E-03	4.1E-02	1.2E+00	2.8E+00	1.0E+00	4.0	9.8E-09	3
Indeno(1,2,3-cd)Pyrene	2.50E-01	1.0E+00	6.7E+00	3.8E+00	1.7E+01	6.0E-01	4.0	1.7E-06	2
Phenanthrene	3.00E-01	1.4E-01	7.4E-01	1.1E+00	4.1E+00	1.0E+00	4.0	2.5E-07	2
Phenol	8.86E+00	4.3E-03	1.6E-02	3.6E-01	8.6E-01	1.0E+00	4.0	1.8E-07	3
Arsenic	5.60E+01	1.0E-03	NA	NA	NA	NA	4.0	2.2E-07	1
Barium	2.55E+01	1.0E-03	NA	NA	NA	NA	4.0	1.0E-07	1
Iron	8.35E+03	1.0E-03	NA	NA	NA	NA	4.0	3.3E-05	1
Zinc	1.40E+01	6.0E-04	NA	NA	NA	NA	4.0	3.3E-08	1

Inorganics: DAevent (mg/cm2-event) =

DA_{event} = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (Eq 1)

Organics: DAevent (mg/cm2-event) =

DA_{event} = t_{event}<t*: DA_{event} (mg/cm^2-event) =
2 x FA x Kp x Cw x (sqrt((6 x τ x t_{event}) / (3.1415))) x CF1 x CF2 (Eq 2)

t_{event}>t*: DA_{event} (mg/cm^2-event) =
FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x ((1 + 3B + 3B^2)/(1+B)^2)) xCF1 x CF2 (Eq 3)

Note:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

Table A-2-12.Supplement B
Current Land Use Scenario (Former Manufacturing Area) - Utility Worker
Groundwater Dermal Contact
Reichhold, Inc., Andover, Massachusetts

Chemical	MW[a]	log Kow[a]	Kow	log Kp[b]	Kp (cm/hr)	B[b]	log D_{sc}/l_{sc}[b]	D_{sc}/l_{sc}[b]	l_{sc} (cm)	D_{sc} (cm^2/hr)	τ_{event}[b] (hr)	t*[b] (hr)
1,2,4-Trimethylbenzene	1.20E+02	3.63E+00	4.27E+03	-1.08E+00	8.37E-02	3.53E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
1,3,5-Trimethylbenzene	1.20E+02	3.42E+00	2.63E+03	-1.22E+00	6.08E-02	2.56E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
Acetone	5.81E+01	-2.40E-01	5.75E-01	-3.28E+00	5.20E-04	1.53E-03	-3.13E+00	7.49E-04	1.00E-03	7.49E-07	2.22E-01	5.34E-01
Benzo(g,h,i)perylene	2.76E+02	6.63E+00	4.27E+06	3.02E-02	1.07E+00	6.85E+00	-4.35E+00	4.51E-05	1.00E-03	4.51E-08	3.69E+00	1.65E+01
Fluorene	1.66E+02	4.18E+00	1.51E+04	-9.72E-01	1.07E-01	5.29E-01	-3.73E+00	1.86E-04	1.00E-03	1.86E-07	8.97E-01	2.15E+00
Isopropylbenzene	1.20E+02	3.66E+00	4.57E+03	-1.06E+00	8.76E-02	3.69E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
Methyl tert butyl ether	8.82E+01	9.40E-01	8.71E+00	-2.67E+00	2.12E-03	7.66E-03	-3.29E+00	5.09E-04	1.00E-03	5.09E-07	3.28E-01	7.87E-01
n-Butylbenzene	1.34E+02	4.38E+00	2.40E+04	-6.61E-01	2.18E-01	9.73E-01	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.29E+00
n-Propylbenzene	1.20E+02	3.69E+00	4.90E+03	-1.04E+00	9.17E-02	3.87E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
o-Xylene	1.06E+02	3.12E+00	1.32E+03	-1.34E+00	4.62E-02	1.83E-01	-3.39E+00	4.03E-04	1.00E-03	4.03E-07	4.13E-01	9.92E-01
p-Isopropyltoluene	1.34E+02	4.10E+00	1.26E+04	-8.46E-01	1.43E-01	6.36E-01	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.35E+00

Note:

[a] Values obtained from DermWin, v. 1.43 (EPA, 2000). Available online at http://www.epa.gov/opptintr/exposure/pubs/episuite.htm.

[b] Equations from Risk Assessment Guidance for Superfund Volume 1; Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005. July 2004).

Table A-2-13
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Volatiles from Groundwater: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	8.3E-03	1.4E-03	1.1E-05	7.0E-03	1.6E-03
1,2-Dichlorobenzene	9.4E-05	1.4E-03	1.3E-07	2.0E-01	6.4E-07
1,3,5-Trimethylbenzene	4.3E-04	1.4E-03	5.8E-07	N/A	N/A
1,3-Dichlorobenzene	4.3E-05	1.4E-03	6.0E-08	2.0E-01	3.0E-07
1,4-Dichlorobenzene	1.4E-04	1.4E-03	1.9E-07	8.0E-01	2.4E-07
4-Methyl-2-pentanone	3.5E-03	1.4E-03	4.7E-06	3.0E+00	1.6E-06
Acetone	3.3E-04	1.4E-03	4.5E-07	8.0E-01	5.6E-07
Benzene	5.5E-05	1.4E-03	7.5E-08	3.0E-02	2.5E-06
Chlorobenzene	6.1E-04	1.4E-03	8.3E-07	5.0E-02	1.7E-05
Ethylbenzene	3.4E-04	1.4E-03	4.6E-07	1.0E+00	4.6E-07
Isopropylbenzene	6.0E-04	1.4E-03	8.2E-07	4.0E-01	2.0E-06
Methyl tert butyl ether	7.0E-05	1.4E-03	9.6E-08	3.0E+00	3.2E-08
Naphthalene	3.7E-04	1.4E-03	5.1E-07	3.0E-03	1.7E-04
n-Butylbenzene	3.0E-04	1.4E-03	4.1E-07	N/A	N/A
n-Propylbenzene	6.5E-04	1.4E-03	8.9E-07	1.0E+00	8.9E-07
o-Xylene	4.6E-04	1.4E-03	6.3E-07	1.0E-01	6.3E-06
p/m-Xylene	4.9E-03	1.4E-03	6.7E-06	1.0E-01	6.7E-05
p-Isopropyltoluene	4.7E-05	1.4E-03	6.4E-08	4.0E-01	1.6E-07
Toluene	1.5E-04	1.4E-03	2.0E-07	5.0E+00	4.1E-08
Hazard Index					2E-03

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	4	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	365	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED* CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-2-14
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Volatiles from Groundwater: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	8.3E-03	1.8E-05	1.5E-07	N/A	N/A
1,2-Dichlorobenzene	9.4E-05	1.8E-05	1.7E-09	N/A	N/A
1,3,5-Trimethylbenzene	4.3E-04	1.8E-05	7.8E-09	N/A	N/A
1,3-Dichlorobenzene	4.3E-05	1.8E-05	7.9E-10	N/A	N/A
1,4-Dichlorobenzene	1.4E-04	1.8E-05	2.6E-09	6.9E-03	1.8E-11
4-Methyl-2-pentanone	3.5E-03	1.8E-05	6.3E-08	N/A	N/A
Acetone	3.3E-04	1.8E-05	6.0E-09	N/A	N/A
Benzene	5.5E-05	1.8E-05	1.0E-09	7.8E-03	7.8E-12
Chlorobenzene	6.1E-04	1.8E-05	1.1E-08	N/A	N/A
Ethylbenzene	3.4E-04	1.8E-05	6.1E-09	N/A	N/A
Isopropylbenzene	6.0E-04	1.8E-05	1.1E-08	N/A	N/A
Methyl tert butyl ether	7.0E-05	1.8E-05	1.3E-09	N/A	N/A
Naphthalene	3.7E-04	1.8E-05	6.8E-09	N/A	N/A
n-Butylbenzene	3.0E-04	1.8E-05	5.5E-09	N/A	N/A
n-Propylbenzene	6.5E-04	1.8E-05	1.2E-08	N/A	N/A
o-Xylene	4.6E-04	1.8E-05	8.4E-09	N/A	N/A
p/m-Xylene	4.9E-03	1.8E-05	8.9E-08	N/A	N/A
p-Isopropyltoluene	4.7E-05	1.8E-05	8.5E-10	N/A	N/A
Toluene	1.5E-04	1.8E-05	2.7E-09	N/A	N/A
Cancer Risk					3E-11

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	4	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED* CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

Table A-2-14.Supplement A
Current Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Volatiles from Groundwater
Reichhold, Inc., Andover, Massachusetts

Chemical	Concentration in Water (mg/L)	Concentration in Water (g/m^3) C_L	Dimensionless Henry's Law Constant (H') K_{eq}	Diffusion coefficient in air (cm^2/s) D_a	Diffusion coefficient in water (cm^2/s) D_w	Schmidt Number Sc_g	Effective diameter of source (m) d_e	Liquid-phase mass transfer coef (m/s) k_L	k_G (m/s)	1/K	K (m/s)	E (g/s)	Concentration in Air (mg/m^3) C_{air}
1,2,4-Trimethylbenzene	2.43E-01	2.43E-01	2.34E-01	7.50E-02	7.10E-06	2.01E+00	1.13E+01	2.47E-06	2.31E-03	4.07E+05	2.45E-06	5.96E-05	8.28E-03
1,2-Dichlorobenzene	2.59E-03	2.59E-03	7.79E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.84E+05	2.61E-06	6.74E-07	9.36E-05
1,3,5-Trimethylbenzene	1.25E-02	1.25E-02	3.16E-01	7.50E-02	7.10E-06	2.01E+00	1.13E+01	2.47E-06	2.31E-03	4.07E+05	2.46E-06	3.06E-06	4.26E-04
1,3-Dichlorobenzene	1.20E-03	1.20E-03	7.79E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.84E+05	2.61E-06	3.13E-07	4.35E-05
1,4-Dichlorobenzene	3.91E-03	3.91E-03	9.96E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.82E+05	2.62E-06	1.02E-06	1.42E-04
4-Methyl-2-pentanone	1.14E-01	1.14E-01	5.74E-03	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	4.56E+05	2.19E-06	2.49E-05	3.46E-03
Acetone	1.15E-02	1.15E-02	1.59E-03	1.24E-01	1.14E-05	1.22E+00	1.13E+01	3.38E-06	3.24E-03	4.90E+05	2.04E-06	2.35E-06	3.26E-04
Benzene	1.30E-03	1.30E-03	2.28E-01	8.80E-02	9.80E-06	1.71E+00	1.13E+01	3.06E-06	2.57E-03	3.29E+05	3.04E-06	3.95E-07	5.49E-05
Chlorobenzene	1.56E-02	1.56E-02	1.52E-01	7.30E-02	8.70E-06	2.07E+00	1.13E+01	2.82E-06	2.27E-03	3.57E+05	2.80E-06	4.36E-06	6.06E-04
Ethylbenzene	9.26E-03	9.26E-03	3.23E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	2.42E-06	3.36E-04
Isopropylbenzene	1.64E-02	1.64E-02	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	4.30E-06	5.97E-04
Methyl tert butyl ether	1.64E-03	1.64E-03	2.40E-02	1.02E-01	1.05E-05	1.47E+00	1.13E+01	3.20E-06	2.85E-03	3.27E+05	3.06E-06	5.02E-07	6.98E-05
Naphthalene	1.12E-02	1.12E-02	1.98E-02	5.90E-02	7.50E-06	2.56E+00	1.13E+01	2.56E-06	1.97E-03	4.17E+05	2.40E-06	2.69E-06	3.74E-04
n-Butylbenzene	8.21E-03	8.21E-03	5.37E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	2.15E-06	2.99E-04
n-Propylbenzene	1.78E-02	1.78E-02	5.37E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	4.66E-06	6.47E-04
o-Xylene	1.48E-02	1.48E-02	4.21E-01	5.61E-02	6.16E-06	2.69E+00	1.13E+01	2.24E-06	1.90E-03	4.47E+05	2.24E-06	3.31E-06	4.59E-04
p/m-Xylene	1.14E-01	1.14E-01	2.13E-01	8.70E-02	1.00E-05	1.73E+00	1.13E+01	3.10E-06	2.55E-03	3.25E+05	3.08E-06	3.51E-05	4.88E-03
p-Isopropyltoluene	1.29E-03	1.29E-03	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	3.37E-07	4.68E-05
Toluene	3.86E-03	3.86E-03	2.72E-01	8.70E-02	8.60E-06	1.73E+00	1.13E+01	2.80E-06	2.55E-03	3.58E+05	2.79E-06	1.08E-06	1.49E-04

Concentration in Air (C_{air}) = (mg/m^3)	**1000* E/H * V_{wind} * L**
Emissions from Liquid surface (E) = (g/s)	**K * A * C_L**
Overall Mas Transfer Coefficient (K) = (m/s)	**$1/K = 1/k_L + 1/k_G * K_{eq}$**
Liquid-phase Mass Transfer Coefficient (k_L) = (m/s)	**$2.78E-06 * (D_w/D_{ether})^{2/3}$**
Gas-phase Mass Transfer Coefficient (k_G) = (m/g)	**$4.82E-03 * U^{0.78} * Sc_G^{-0.67} * d_e^{-0.11}$**
Effective Diameter of Source (d_e) = (m)	**$(4 * A / \pi)^{0.5}$**
Schmidt Number Calculation (Sc_G) =	**$u_G/p_G * D_a$**

Parameters		**Values**
C_L	Concentration in liquid phase (g/m^3)	chemical specific
K	overall mass transfer coefficient (m/s)	calculated
k_L	liquid-phase mass transfer coefficient (m/s)	calculated
k_G	gas-phase mass transfer coefficient (m/s)	calculated
K_{eq}	Equilibrium constant (Henry's Law constant)	chemical specific
D_{ether}	Diffusion coefficient of ether in water (cm^2/s)	8.50E-06
D_w	Diffusion coefficient in water (cm^2/s)	chemical specific
U	Windspeed (m/s)	1
A	Area of the source (m^2)	100
u_G	viscosity of air (g/cm-s)	1.81E-04
p_G	density of air (g/cm^3)	1.20E-03
D_a	Diffusion coefficient in air (cm^2/s)	chemical specific
H	Height of breathing zone (m)	2
Vwind	Average wind speed in breathing zone (m/s)	2.25
L	Length of breathing zone perpendicular to wind (m)	1.6

Note:

Chemical and physical properties from EPA Region 9 PRG Table (EPA, 2004).

Isopropylbenzene used a surrogate for p-Isopropyltoluene

Table A-2-15
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Incidental Concrete Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	4.7E-09	1.3E-10	1.0E+00	1.3E-10
p/m-Xylene	4.0E-03	1.0E+00	4.7E-09	1.9E-11	2.0E-01	9.4E-11
Phenol	3.3E+00	1.0E+00	4.7E-09	1.6E-08	3.0E-01	5.2E-08
Barium	5.8E+01	1.0E+00	4.7E-09	2.7E-07	7.0E-02	3.9E-06
Cadmium	1.2E+00	1.0E+00	4.7E-09	5.7E-09	1.0E-03	5.7E-06
Chromium (Total)	3.5E+01	1.0E+00	4.7E-09	1.7E-07	2.0E-02	8.3E-06
Chromium (III)	4.3E+01	1.0E+00	4.7E-09	2.0E-07	1.0E+00	2.0E-07
Copper	2.9E+01	3.9E-01	1.8E-09	5.4E-08	4.0E-02	1.3E-06
Iron	1.8E+04	3.9E-01	1.8E-09	3.2E-05	7.0E-01	4.6E-05
Zinc	1.1E+02	1.0E+00	4.7E-09	5.4E-07	3.0E-01	1.8E-06
C19-C36 Aliphatics	3.9E+01	1.0E+00	4.7E-09	1.8E-07	6.0E+00	3.0E-08
Hazard Index						7E-05

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-16
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Incidental Concrete Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-17
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Concrete Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E-01	4.8E-09	1.3E-10	1.0E+00	1.3E-10
p/m-Xylene	4.0E-03	1.2E-01	5.7E-09	2.3E-11	2.0E-01	1.1E-10
Phenol	3.3E+00	2.6E-01	1.2E-08	4.1E-08	3.0E-01	1.4E-07
Barium	5.8E+01	5.0E-02	2.4E-09	1.4E-07	7.0E-02	2.0E-06
Cadmium	1.2E+00	1.4E-01	6.7E-09	8.1E-09	1.0E-03	8.1E-06
Chromium (Total)	3.5E+01	9.0E-02	4.3E-09	1.5E-07	2.0E-02	7.5E-06
Chromium (III)	4.3E+01	4.0E-02	1.9E-09	8.2E-08	1.0E+00	8.2E-08
Copper	2.9E+01	3.0E-02	1.4E-09	4.2E-08	4.0E-02	1.0E-06
Iron	1.8E+04	3.0E-02	1.4E-09	2.5E-05	7.0E-01	3.6E-05
Zinc	1.1E+02	2.0E-02	9.5E-10	1.1E-07	3.0E-01	3.6E-07
C19-C36 Aliphatics	3.9E+01	1.0E-01	4.8E-09	1.8E-07	6.0E+00	3.1E-08
Hazard Index						6E-05

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-18
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Concrete Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-19
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Ingestion of Inhaled Particulates from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	2.6E-09	4.1E-03	1.0E-11	1.0E+00	1.0E-11
p/m-Xylene	4.0E-03	1.0E+00	3.6E-10	4.1E-03	1.5E-12	2.0E-01	7.3E-12
Phenol	3.3E+00	1.0E+00	3.0E-07	4.1E-03	1.2E-09	3.0E-01	4.1E-09
Barium	5.8E+01	1.0E+00	5.2E-06	4.1E-03	2.1E-08	7.0E-02	3.0E-07
Cadmium	1.2E+00	1.0E+00	1.1E-07	4.1E-03	4.4E-10	1.0E-03	4.4E-07
Chromium (Total)	3.5E+01	1.0E+00	3.2E-06	4.1E-03	1.3E-08	2.0E-02	6.5E-07
Chromium (III)	4.3E+01	1.0E+00	3.9E-06	4.1E-03	1.6E-08	1.0E+00	1.6E-08
Copper	2.9E+01	3.9E-01	2.6E-06	1.6E-03	4.2E-09	4.0E-02	1.0E-07
Iron	1.8E+04	3.9E-01	1.6E-03	1.6E-03	2.5E-06	7.0E-01	3.6E-06
Zinc	1.1E+02	1.0E+00	1.0E-05	4.1E-03	4.2E-08	3.0E-01	1.4E-07
C19-C36 Aliphatics	3.9E+01	1.0E+00	3.5E-06	4.1E-03	1.4E-08	6.0E+00	2.4E-09
Hazard Index							5E-06

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-2-20
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Ingestion of Inhaled Particulates from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	2.6E-09	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	3.6E-10	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	3.0E-07	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	5.2E-06	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	1.1E-07	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	3.2E-06	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	3.9E-06	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	2.6E-06	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	1.6E-03	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	1.0E-05	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	3.5E-06	N/A	N/A	N/A	N/A
Cancer Risk							0E+00

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-2-21
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Particulates from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	RfC (mg/m^3)	RFD_{Inhal} (mg/kg/day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	8.5E-10	4.1E-03	3.5E-12	8.0E-01	2.3E-01	1.5E-11
p/m-Xylene	4.0E-03	1.0E+00	1.2E-10	4.1E-03	4.9E-13	1.0E-01	2.9E-02	1.7E-11
Phenol	3.3E+00	1.0E+00	9.9E-08	4.1E-03	4.1E-10	2.6E-01	7.4E-02	5.5E-09
Barium	5.8E+01	1.0E+00	1.7E-06	4.1E-03	7.1E-09	5.0E-03	1.4E-03	5.0E-06
Cadmium	1.2E+00	1.0E+00	3.6E-08	4.1E-03	1.5E-10	2.0E-05	5.7E-06	2.6E-05
Chromium (Total)	3.5E+01	1.0E+00	1.1E-06	4.1E-03	4.3E-09	1.0E-04	2.9E-05	1.5E-04
Chromium (III)	4.3E+01	1.0E+00	1.3E-06	4.1E-03	5.3E-09	3.0E-04	8.6E-05	6.2E-05
Copper	2.9E+01	1.0E+00	8.7E-07	4.1E-03	3.6E-09	N/A	N/A	N/A
Iron	1.8E+04	1.0E+00	5.3E-04	4.1E-03	2.2E-06	N/A	N/A	N/A
Zinc	1.1E+02	1.0E+00	3.4E-06	4.1E-03	1.4E-08	1.4E-03	4.0E-04	3.5E-05
C19-C36 Aliphatics	3.9E+01	1.0E+00	1.2E-06	4.1E-03	4.7E-09	N/A	N/A	N/A
Hazard Index								3E-04

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION
RfD_{inhal} = [RfC *INH (20 m^3/day)] / BW (70 kg)

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-2-22
Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Particulates from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	Unit Risk $(mg/m^3)^{-1}$	CSF_{inhal} (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	1.0E+00	8.5E-10	5.4E-05	4.6E-14	N/A	N/A	N/A
p/m-Xylene	4.0E-03	1.0E+00	1.2E-10	5.4E-05	6.5E-15	N/A	N/A	N/A
Phenol	3.3E+00	1.0E+00	9.9E-08	5.4E-05	5.4E-12	N/A	N/A	N/A
Barium	5.8E+01	1.0E+00	1.7E-06	5.4E-05	9.4E-11	N/A	N/A	N/A
Cadmium	1.2E+00	1.0E+00	3.6E-08	5.4E-05	2.0E-12	1.8E-03	6.3E-03	1.2E-14
Chromium (Total)	3.5E+01	1.0E+00	1.1E-06	5.4E-05	5.7E-11	1.2E-02	4.2E-02	2.4E-12
Chromium (III)	4.3E+01	1.0E+00	1.3E-06	5.4E-05	7.1E-11	N/A	N/A	N/A
Copper	2.9E+01	1.0E+00	8.7E-07	5.4E-05	4.8E-11	N/A	N/A	N/A
Iron	1.8E+04	1.0E+00	5.3E-04	5.4E-05	2.9E-08	N/A	N/A	N/A
Zinc	1.1E+02	1.0E+00	3.4E-06	5.4E-05	1.9E-10	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	1.0E+00	1.2E-06	5.4E-05	6.3E-11	N/A	N/A	N/A
Cancer Risk								2E-12

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	3	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION
CSF_{inhal} = [CSF_{oral} * BW (70 kg)] / INH (20 m^3/day)

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-2-23
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Volatiles from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Acetone	2.8E-02	1.2E+04	1.4E-07	2.7E-03	4.0E-10	8.0E-01	4.9E-10
p/m-Xylene	4.0E-03	5.2E+03	4.6E-08	2.7E-03	1.3E-10	1.0E-01	1.3E-09
Phenol	3.3E+00	N/A	N/A	2.7E-03	N/A	2.6E-01	N/A
Barium	5.8E+01	N/A	N/A	2.7E-03	N/A	5.0E-03	N/A
Cadmium	1.2E+00	N/A	N/A	2.7E-03	N/A	2.0E-05	N/A
Chromium (Total)	3.5E+01	N/A	N/A	2.7E-03	N/A	1.0E-04	N/A
Chromium (III)	4.3E+01	N/A	N/A	2.7E-03	N/A	3.0E-04	N/A
Copper	2.9E+01	N/A	N/A	2.7E-03	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	2.7E-03	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	2.7E-03	N/A	1.4E-03	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	2.7E-03	N/A	N/A	N/A
Hazard Index							2E-09

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	365	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete / VF

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

VF = Volatilization Factor

Table A-2-24
Current/Future Land Use Scenario (Former Manufacturing Area) - Utility Worker
Inhalation of Airborne Volatiles from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Acetone	2.8E-02	1.2E+04	1.4E-07	3.7E-05	5.3E-12	N/A	N/A
p/m-Xylene	4.0E-03	5.2E+03	4.6E-08	3.7E-05	1.7E-12	N/A	N/A
Phenol	3.3E+00	N/A	N/A	3.7E-05	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	3.7E-05	N/A	1.8E-03	N/A
Chromium (Total)	3.5E+01	N/A	N/A	3.7E-05	N/A	1.2E-02	N/A
Chromium (III)	4.3E+01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	3.7E-05	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	3.7E-05	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	3.7E-05	N/A	N/A	N/A
Cancer Risk							0E+00

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	3	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete / VF

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

VF = Volatilization Factor

Table A-3-1
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	9.9E-01	9.7E-08	1.3E-05	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	9.8E-08	2.3E-07	9.0E-02	2.5E-06
1,3,5-Trimethylbenzene	4.6E+01	9.9E-01	9.7E-08	4.4E-06	1.0E-02	4.4E-04
1,4-Dichlorobenzene	1.3E+00	1.0E+00	9.8E-08	1.2E-07	9.0E-02	1.4E-06
2-Butanone	1.0E+01	1.0E+00	9.8E-08	1.0E-06	6.0E-01	1.7E-06
4-Methyl-2-pentanone	8.4E+00	1.0E+00	9.8E-08	8.2E-07	8.0E-02	1.0E-05
Acetone	8.7E+00	1.0E+00	9.8E-08	8.5E-07	9.0E-01	9.4E-07
Benzene	8.9E-01	1.0E+00	9.8E-08	8.7E-08	4.0E-03	2.2E-05
Carbon disulfide	1.5E+00	9.9E-01	9.7E-08	1.4E-07	1.0E-01	1.4E-06
Chlorobenzene	1.8E+00	1.0E+00	9.8E-08	1.7E-07	2.0E-02	8.7E-06
Ethylbenzene	6.2E+01	1.0E+00	9.8E-08	6.0E-06	1.0E-01	6.0E-05
Isopropylbenzene	1.9E+00	9.9E-01	9.7E-08	1.8E-07	1.0E-01	1.8E-06
n-Butylbenzene	1.0E+01	9.9E-01	9.7E-08	9.7E-07	5.0E-02	1.9E-05
n-Propylbenzene	4.1E+00	9.9E-01	9.7E-08	4.0E-07	1.0E-01	4.0E-06
Naphthalene	9.5E+00	3.6E-01	3.5E-08	3.3E-07	2.0E-02	1.7E-05
Methyl tert butyl ether	1.1E+00	1.0E+00	9.8E-08	1.0E-07	1.0E-01	1.0E-06
Methylene chloride	5.1E+00	1.0E+00	9.8E-08	5.0E-07	6.0E-03	8.3E-05
o-Xylene	1.1E+01	1.0E+00	9.8E-08	1.1E-06	2.0E-01	5.4E-06
p-Isopropyltoluene	1.7E+00	9.9E-01	9.7E-08	1.6E-07	1.0E-01	1.6E-06
p/m-Xylene	6.2E+01	1.0E+00	9.8E-08	6.1E-06	2.0E-01	3.0E-05
sec-Butylbenzene	1.2E+00	9.9E-01	9.7E-08	1.2E-07	N/A	N/A
Styrene	5.6E+00	1.0E+00	9.8E-08	5.5E-07	2.0E-01	2.7E-06
Toluene	1.9E+00	1.0E+00	9.8E-08	1.9E-07	8.0E-02	2.4E-06
Total Xylenes	1.2E+02	1.0E+00	9.8E-08	1.2E-05	2.0E-01	5.9E-05
2,4-Dimethylphenol	4.2E-01	1.0E+00	9.8E-08	4.2E-08	2.0E-02	2.1E-06
3-Methylphenol/4-Methylphenol	5.5E-01	9.1E-01	8.9E-08	4.9E-08	5.0E-02	9.7E-07
Phenol	1.3E+01	1.0E+00	9.8E-08	1.3E-06	3.0E-01	4.2E-06
2-Methylnaphthalene	1.2E+00	3.6E-01	3.5E-08	4.1E-08	4.0E-03	1.0E-05
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	9.8E-08	2.7E-08	2.0E-02	1.4E-06
Dibenzofuran	3.0E-01	9.1E-01	8.9E-08	2.7E-08	1.0E-03	2.7E-05
Phenanthrene	6.1E-01	3.6E-01	3.5E-08	2.1E-08	3.0E-02	7.1E-07
Arsenic	7.8E+00	1.0E+00	9.8E-08	7.6E-07	3.0E-04	2.5E-03
Barium	2.2E+01	1.0E+00	9.8E-08	2.2E-06	2.0E-01	1.1E-05
Cadmium	4.7E+00	1.0E+00	9.8E-08	4.6E-07	1.0E-03	4.6E-04
Chromium	1.7E+01	1.0E+00	9.8E-08	1.7E-06	3.0E-03	5.5E-04
Copper	1.6E+01	3.9E-01	3.8E-08	6.3E-07	4.0E-02	1.6E-05
Iron	9.5E+03	3.9E-01	3.8E-08	3.6E-04	7.0E-01	5.2E-04
Lead	2.3E+01	5.0E-01	4.9E-08	1.1E-06	7.5E-04	1.5E-03
Silver	3.0E-01	1.0E+00	9.8E-08	2.9E-08	5.0E-03	5.9E-06
Zinc	7.4E+02	1.0E+00	9.8E-08	7.3E-05	3.0E-01	2.4E-04
Hazard Index						7E-03

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-3-2
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	3.5E-08	4.4E-08	2.4E-02	1.1E-09
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	3.5E-08	3.1E-08	5.5E-02	1.7E-09
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	6.2E+01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	3.5E-08	1.8E-07	2.0E-03	3.6E-10
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	3.5E-08	2.0E-07	3.0E-02	5.9E-09
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	3.5E-08	9.7E-09	1.4E-02	1.4E-10
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	3.5E-08	2.7E-07	1.5E+00	4.1E-07
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.7E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.6E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	7.4E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						4E-07

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-3-3
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.1E-01	2.2E-08	3.0E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E-01	2.0E-08	4.6E-08	9.0E-02	5.1E-07
1,3,5-Trimethylbenzene	4.6E+01	1.1E-01	2.2E-08	1.0E-06	1.0E-02	1.0E-04
1,4-Dichlorobenzene	1.3E+00	1.0E-01	2.0E-08	2.5E-08	9.0E-02	2.8E-07
2-Butanone	1.0E+01	1.0E-01	2.0E-08	2.1E-07	6.0E-01	3.5E-07
4-Methyl-2-pentanone	8.4E+00	1.0E-01	2.0E-08	1.7E-07	8.0E-02	2.1E-06
Acetone	8.7E+00	1.0E-01	2.0E-08	1.7E-07	9.0E-01	1.9E-07
Benzene	8.9E-01	8.0E-02	1.6E-08	1.4E-08	4.0E-03	3.5E-06
Carbon disulfide	1.5E+00	1.1E-01	2.2E-08	3.3E-08	1.0E-01	3.3E-07
Chlorobenzene	1.8E+00	1.0E-01	2.0E-08	3.6E-08	2.0E-02	1.8E-06
Ethylbenzene	6.2E+01	2.0E-01	4.0E-08	2.5E-06	1.0E-01	2.5E-05
Isopropylbenzene	1.9E+00	1.1E-01	2.2E-08	4.2E-08	1.0E-01	4.2E-07
n-Butylbenzene	1.0E+01	1.1E-01	2.2E-08	2.2E-07	5.0E-02	4.4E-06
n-Propylbenzene	4.1E+00	1.1E-01	2.2E-08	9.0E-08	1.0E-01	9.0E-07
Naphthalene	9.5E+00	1.0E-01	2.0E-08	1.9E-07	2.0E-02	9.5E-06
Methyl tert butyl ether	1.1E+00	1.0E-01	2.0E-08	2.1E-08	1.0E-01	2.1E-07
Methylene chloride	5.1E+00	1.0E-01	2.0E-08	1.0E-07	6.0E-03	1.7E-05
o-Xylene	1.1E+01	1.2E-01	2.4E-08	2.6E-07	2.0E-01	1.3E-06
p-Isopropyltoluene	1.7E+00	1.1E-01	2.2E-08	3.6E-08	1.0E-01	3.6E-07
p/m-Xylene	6.2E+01	1.2E-01	2.4E-08	1.5E-06	2.0E-01	7.5E-06
sec-Butylbenzene	1.2E+00	1.1E-01	2.2E-08	2.6E-08	N/A	N/A
Styrene	5.6E+00	2.0E-01	4.0E-08	2.2E-07	2.0E-01	1.1E-06
Toluene	1.9E+00	1.2E-01	2.4E-08	4.7E-08	8.0E-02	5.9E-07
Total Xylenes	1.2E+02	1.2E-01	2.4E-08	2.9E-06	2.0E-01	1.4E-05
2,4-Dimethylphenol	4.2E-01	2.6E-01	5.2E-08	2.2E-08	2.0E-02	1.1E-06
3-Methylphenol/4-Methylphenol	5.5E-01	1.7E-01	3.4E-08	1.9E-08	5.0E-02	3.7E-07
Phenol	1.3E+01	2.6E-01	5.2E-08	6.8E-07	3.0E-01	2.3E-06
2-Methylnaphthalene	1.2E+00	1.0E-01	2.0E-08	2.3E-08	4.0E-03	5.8E-06
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	4.0E-09	1.1E-09	2.0E-02	5.5E-08
Dibenzofuran	3.0E-01	1.7E-01	3.4E-08	1.0E-08	1.0E-03	1.0E-05
Phenanthrene	6.1E-01	1.0E-01	2.0E-08	1.2E-08	3.0E-02	4.1E-07
Arsenic	7.8E+00	3.0E-02	6.0E-09	4.7E-08	3.0E-04	1.6E-04
Barium	2.2E+01	5.0E-02	1.0E-08	2.2E-07	2.0E-01	1.1E-06
Cadmium	4.7E+00	1.4E-01	2.8E-08	1.3E-07	1.0E-03	1.3E-04
Chromium	1.7E+01	9.0E-02	1.8E-08	3.0E-07	3.0E-03	1.0E-04
Copper	1.6E+01	3.0E-02	6.0E-09	9.9E-08	4.0E-02	2.5E-06
Iron	9.5E+03	3.0E-02	6.0E-09	5.7E-05	7.0E-01	8.1E-05
Lead	2.3E+01	6.0E-03	1.2E-09	2.8E-08	7.5E-04	3.7E-05
Silver	3.0E-01	2.5E-01	5.0E-08	1.5E-08	5.0E-03	3.0E-06
Zinc	7.4E+02	2.0E-02	4.0E-09	3.0E-06	3.0E-01	9.9E-06
Hazard Index						7E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-3-4
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E-01	7.2E-09	9.0E-09	2.4E-02	2.2E-10
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	8.0E-02	5.8E-09	5.1E-09	5.5E-02	2.8E-10
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	6.2E+01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E-01	7.2E-09	3.7E-08	2.0E-03	7.4E-11
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	2.0E-01	1.4E-08	8.1E-08	3.0E-02	2.4E-09
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	1.4E-09	4.0E-10	1.4E-02	5.6E-12
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	3.0E-02	2.2E-09	1.7E-08	1.5E+00	2.5E-08
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.7E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.6E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	7.4E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						3E-08

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-3-5
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	8.8E-05	1.4E-01	1.2E-05	7.0E-03	1.7E-03
1,2-Dichlorobenzene	2.3E+00	1.4E+04	7.3E-05	1.4E-01	1.0E-05	2.0E-01	5.0E-05
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	8.3E-05	1.4E-01	1.1E-05	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	8.2E-05	1.4E-01	1.1E-05	8.0E-01	1.4E-05
2-Butanone	1.0E+01	1.3E+04	7.9E-05	1.4E-01	1.1E-05	5.0E+00	2.2E-06
4-Methyl-2-pentanone	8.4E+00	9.9E+03	1.0E-04	1.4E-01	1.4E-05	3.0E+00	4.6E-06
Acetone	8.7E+00	1.2E+04	8.5E-05	1.4E-01	1.2E-05	8.0E-01	1.5E-05
Benzene	8.9E-01	2.6E+03	3.9E-04	1.4E-01	5.3E-05	3.0E-02	1.8E-03
Carbon disulfide	1.5E+00	1.1E+03	8.9E-04	1.4E-01	1.2E-04	7.0E-01	1.7E-04
Chlorobenzene	1.8E+00	5.9E+03	1.7E-04	1.4E-01	2.3E-05	5.0E-02	4.7E-04
Ethylbenzene	6.2E+01	5.1E+03	2.0E-04	1.4E-01	2.7E-05	1.0E+00	2.7E-05
Isopropylbenzene	1.9E+00	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
n-Butylbenzene	1.0E+01	7.7E+03	1.3E-04	1.4E-01	1.8E-05	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	1.7E-04	1.4E-01	2.3E-05	1.0E+00	2.3E-05
Naphthalene	9.5E+00	5.2E+04	1.9E-05	1.4E-01	2.7E-06	3.0E-03	8.8E-04
Methyl tert butyl ether	1.1E+00	3.9E+03	2.6E-04	1.4E-01	3.5E-05	3.0E+00	1.2E-05
Methylene chloride	5.1E+00	2.3E+03	4.3E-04	1.4E-01	5.9E-05	6.0E-01	9.8E-05
o-Xylene	1.1E+01	5.8E+03	1.7E-04	1.4E-01	2.4E-05	1.0E-01	2.4E-04
p-Isopropyltoluene	1.7E+00	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
p/m-Xylene	6.2E+01	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
sec-Butylbenzene	1.2E+00	7.0E+03	1.4E-04	1.4E-01	2.0E-05	N/A	N/A
Styrene	5.6E+00	1.3E+04	8.0E-05	1.4E-01	1.1E-05	1.0E+00	1.1E-05
Toluene	1.9E+00	3.7E+03	2.7E-04	1.4E-01	3.7E-05	5.0E+00	7.3E-06
Total Xylenes	1.2E+02	5.2E+03	1.9E-04	1.4E-01	2.7E-05	1.0E-01	2.7E-04
2,4-Dimethylphenol	4.2E-01	N/A	1.4E-08	1.4E-01	1.9E-09	7.0E-02	2.7E-08
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	1.8E-08	1.4E-01	2.4E-09	N/A	N/A
Phenol	1.3E+01	N/A	4.2E-07	1.4E-01	5.7E-08	2.6E-01	2.2E-07
2-Methylnaphthalene	1.2E+00	N/A	3.7E-08	1.4E-01	5.1E-09	5.0E-02	1.0E-07
bis(2-Ethylhexyl)phthalate	2.8E-01	N/A	8.8E-09	1.4E-01	1.2E-09	7.0E-03	1.7E-07
Dibenzofuran	3.0E-01	N/A	9.6E-09	1.4E-01	1.3E-09	N/A	N/A
Phenanthrene	6.1E-01	N/A	1.9E-08	1.4E-01	2.7E-09	5.0E-02	5.3E-08
Arsenic	7.8E+00	N/A	2.5E-07	1.4E-01	3.4E-08	2.5E-06	1.4E-02
Barium	2.2E+01	N/A	7.1E-07	1.4E-01	9.7E-08	5.0E-04	1.9E-04
Cadmium	4.7E+00	N/A	1.5E-07	1.4E-01	2.1E-08	2.0E-05	1.0E-03
Chromium	1.7E+01	N/A	5.4E-07	1.4E-01	7.4E-08	1.0E-04	7.4E-04
Copper	1.6E+01	N/A	5.3E-07	1.4E-01	7.2E-08	N/A	N/A
Iron	9.5E+03	N/A	3.0E-04	1.4E-01	4.2E-05	N/A	N/A
Lead	2.3E+01	N/A	7.4E-07	1.4E-01	1.0E-07	1.0E-03	1.0E-04
Silver	3.0E-01	N/A	9.6E-09	1.4E-01	1.3E-09	1.4E-04	9.4E-06
Zinc	7.4E+02	N/A	2.4E-05	1.4E-01	3.3E-06	1.4E-03	2.3E-03
Hazard Index							2E-02

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-3-6
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	8.8E-05	4.9E-02	4.3E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.4E+04	7.3E-05	4.9E-02	3.6E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	8.3E-05	4.9E-02	4.1E-06	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	8.2E-05	4.9E-02	4.1E-06	6.9E-03	2.8E-08
2-Butanone	1.0E+01	1.3E+04	7.9E-05	4.9E-02	3.9E-06	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	9.9E+03	1.0E-04	4.9E-02	5.0E-06	N/A	N/A
Acetone	8.7E+00	1.2E+04	8.5E-05	4.9E-02	4.2E-06	N/A	N/A
Benzene	8.9E-01	2.6E+03	3.9E-04	4.9E-02	1.9E-05	7.8E-03	1.5E-07
Carbon disulfide	1.5E+00	1.1E+03	8.9E-04	4.9E-02	4.4E-05	N/A	N/A
Chlorobenzene	1.8E+00	5.9E+03	1.7E-04	4.9E-02	8.4E-06	N/A	N/A
Ethylbenzene	6.2E+01	5.1E+03	2.0E-04	4.9E-02	9.8E-06	N/A	N/A
Isopropylbenzene	1.9E+00	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
n-Butylbenzene	1.0E+01	7.7E+03	1.3E-04	4.9E-02	6.4E-06	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	1.7E-04	4.9E-02	8.2E-06	N/A	N/A
Naphthalene	9.5E+00	5.2E+04	1.9E-05	4.9E-02	9.6E-07	N/A	N/A
Methyl tert butyl ether	1.1E+00	3.9E+03	2.6E-04	4.9E-02	1.3E-05	N/A	N/A
Methylene chloride	5.1E+00	2.3E+03	4.3E-04	4.9E-02	2.1E-05	1.0E-05	2.1E-10
o-Xylene	1.1E+01	5.8E+03	1.7E-04	4.9E-02	8.6E-06	N/A	N/A
p-Isopropyltoluene	1.7E+00	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
p/m-Xylene	6.2E+01	5.2E+03	1.9E-04	4.9E-02	9.5E-06	N/A	N/A
sec-Butylbenzene	1.2E+00	7.0E+03	1.4E-04	4.9E-02	7.0E-06	N/A	N/A
Styrene	5.6E+00	1.3E+04	8.0E-05	4.9E-02	3.9E-06	5.7E-04	2.2E-09
Toluene	1.9E+00	3.7E+03	2.7E-04	4.9E-02	1.3E-05	N/A	N/A
Total Xylenes	1.2E+02	5.2E+03	1.9E-04	4.9E-02	9.6E-06	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	1.4E-08	4.9E-02	6.7E-10	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	1.8E-08	4.9E-02	8.6E-10	N/A	N/A
Phenol	1.3E+01	N/A	4.2E-07	4.9E-02	2.0E-08	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	3.7E-08	4.9E-02	1.8E-09	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	N/A	8.8E-09	4.9E-02	4.4E-10	1.3E-03	5.7E-13
Dibenzofuran	3.0E-01	N/A	9.6E-09	4.9E-02	4.8E-10	N/A	N/A
Phenanthrene	6.1E-01	N/A	1.9E-08	4.9E-02	9.6E-10	N/A	N/A
Arsenic	7.8E+00	N/A	2.5E-07	4.9E-02	1.2E-08	4.3E+00	5.3E-08
Barium	2.2E+01	N/A	7.1E-07	4.9E-02	3.5E-08	N/A	N/A
Cadmium	4.7E+00	N/A	1.5E-07	4.9E-02	7.5E-09	1.8E+00	1.3E-08
Chromium	1.7E+01	N/A	5.4E-07	4.9E-02	2.7E-08	1.2E+01	3.2E-07
Copper	1.6E+01	N/A	5.3E-07	4.9E-02	2.6E-08	N/A	N/A
Iron	9.5E+03	N/A	3.0E-04	4.9E-02	1.5E-05	N/A	N/A
Lead	2.3E+01	N/A	7.4E-07	4.9E-02	3.7E-08	N/A	N/A
Silver	3.0E-01	N/A	9.6E-09	4.9E-02	4.7E-10	N/A	N/A
Zinc	7.4E+02	N/A	2.4E-05	4.9E-02	1.2E-06	N/A	N/A
Cancer Risk							6E-07

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-3-11
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Concrete Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	9.8E-08	2.8E-09	9.0E-01	3.1E-09
p/m-Xylene	4.0E-03	1.0E+00	9.8E-08	3.9E-10	2.0E-01	2.0E-09
Phenol	3.3E+00	1.0E+00	9.8E-08	3.2E-07	3.0E-01	1.1E-06
C19-C36 Aliphatics	3.9E+01	1.0E+00	9.8E-08	3.8E-06	2.0E+00	1.9E-06
Barium	5.8E+01	1.0E+00	9.8E-08	5.7E-06	2.0E-01	2.8E-05
Cadmium	1.2E+00	1.0E+00	9.8E-08	1.2E-07	1.0E-03	1.2E-04
Chromium (Total)	3.5E+01	1.0E+00	9.8E-08	3.4E-06	3.0E-03	1.1E-03
Chromium (III)	4.3E+01	1.0E+00	9.8E-08	4.2E-06	1.5E+00	2.8E-06
Copper	2.9E+01	3.9E-01	3.8E-08	1.1E-06		2.8E-05
Iron	1.8E+04	3.9E-01	3.8E-08	6.7E-04	7.0E-01	9.6E-04
Zinc	1.1E+02	1.0E+00	9.8E-08	1.1E-05	3.0E-01	3.7E-05
Hazard Index						2E-03

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-3-12
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Incidental Concrete Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-3-14
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Concrete Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E-01	2.0E-08	5.7E-10	9.0E-01	6.3E-10
p/m-Xylene	4.0E-03	1.2E-01	2.4E-08	9.6E-11	2.0E-01	4.8E-10
Phenol	3.3E+00	2.6E-01	5.2E-08	1.7E-07	3.0E-01	5.8E-07
C19-C36 Aliphatics	3.9E+01	1.0E-01	2.0E-08	7.7E-07	2.0E+00	3.9E-07
Barium	5.8E+01	5.0E-02	1.0E-08	5.8E-07	2.0E-01	2.9E-06
Cadmium	1.2E+00	1.4E-01	2.8E-08	3.4E-08	1.0E-03	3.4E-05
Chromium (Total)	3.5E+01	9.0E-02	1.8E-08	6.3E-07	3.0E-03	2.1E-04
Chromium (III)	4.3E+01	4.0E-01	8.0E-08	3.5E-06	1.5E+00	2.3E-06
Copper	2.9E+01	3.0E-02	6.0E-09	1.8E-07	4.0E-02	4.4E-06
Iron	1.8E+04	3.0E-02	6.0E-09	1.1E-04	7.0E-01	1.5E-04
Zinc	1.1E+02	2.0E-02	4.0E-09	4.6E-07	3.0E-01	1.5E-06
Hazard Index						4E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-3-15
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Concrete Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-3-16
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Acetone	2.8E-02	1.2E+04	8.5E-05	1.4E-01	1.2E-05	8.0E-01	1.5E-05
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
Phenol	3.3E+00	N/A	1.1E-07	1.4E-01	1.5E-08	2.6E-01	5.6E-08
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	1.4E-01	1.7E-07	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	1.4E-01	2.5E-07	5.0E-04	5.1E-04
Cadmium	1.2E+00	N/A	3.9E-08	1.4E-01	5.3E-09	2.0E-05	2.7E-04
Chromium (Total)	3.5E+01	N/A	1.1E-06	1.4E-01	1.5E-07	1.0E-04	1.5E-03
Chromium (III)	4.3E+01	N/A	1.4E-06	1.4E-01	1.9E-07	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	1.4E-01	1.3E-07	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	1.4E-01	7.7E-05	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	1.4E-01	5.0E-07	1.4E-03	3.6E-04
Hazard Index							3E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-3-17
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Acetone	2.8E-02	1.2E+04	8.5E-05	4.9E-02	4.2E-06	N/A	N/A
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	4.9E-02	9.4E-06	N/A	N/A
Phenol	3.3E+00	N/A	1.1E-07	4.9E-02	5.2E-09	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	4.9E-02	6.1E-08	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	4.9E-02	9.1E-08	N/A	N/A
Cadmium	1.2E+00	N/A	3.9E-08	4.9E-02	1.9E-09	1.8E-03	3.4E-12
Chromium (Total)	3.5E+01	N/A	1.1E-06	4.9E-02	5.5E-08	1.2E-02	6.7E-10
Chromium (III)	4.3E+01	N/A	1.4E-06	4.9E-02	6.8E-08	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	4.9E-02	4.6E-08	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	4.9E-02	2.8E-05	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	4.9E-02	1.8E-07	N/A	N/A
Cancer Risk							7E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-3-18
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	2.1E-01	2.3E-01	4.9E-02	7.0E-03	**7.0E+00**
1,2-Dichlorobenzene	4.1E-04	2.3E-01	9.4E-05	2.0E-01	4.7E-04
1,2-Dichloroethane	2.9E-05	2.3E-01	6.7E-06	7.0E-03	9.5E-04
1,3,5-Trimethylbenzene	1.1E-01	2.3E-01	2.5E-02	N/A	N/A
1,3-Dichlorobenzene	1.6E-04	2.3E-01	3.7E-05	2.0E-01	1.8E-04
1,4-Dichlorobenzene	2.3E-03	2.3E-01	5.3E-04	8.0E-01	6.6E-04
4-Methyl-2-pentanone	1.4E-03	2.3E-01	3.3E-04	3.0E+00	1.1E-04
Acetone	7.0E-06	2.3E-01	1.6E-06	8.0E-01	2.0E-06
Benzene	9.8E-03	2.3E-01	2.2E-03	3.0E-02	7.5E-02
Chlorobenzene	1.7E-02	2.3E-01	3.9E-03	5.0E-02	7.8E-02
Ethylbenzene	1.6E+00	2.3E-01	3.6E-01	1.0E+00	3.6E-01
Isopropylbenzene	1.3E-02	2.3E-01	3.1E-03	4.0E-01	7.7E-03
Methyl tert butyl ether	1.2E-04	2.3E-01	2.6E-05	3.0E+00	8.8E-06
Naphthalene	1.2E-03	2.3E-01	2.7E-04	3.0E-03	9.0E-02
n-Butylbenzene	7.5E-03	2.3E-01	1.7E-03	N/A	N/A
n-Propylbenzene	1.2E-02	2.3E-01	2.8E-03	1.0E+00	2.8E-03
o-Xylene	1.3E-01	2.3E-01	3.0E-02	1.0E-01	3.0E-01
p/m-Xylene	3.6E-01	2.3E-01	8.3E-02	1.0E-01	8.3E-01
p-Isopropyltoluene	2.2E-02	2.3E-01	5.1E-03	4.0E-01	1.3E-02
sec-Butylbenzene	1.4E-07	2.3E-01	3.1E-08	N/A	N/A
Styrene	7.0E-04	2.3E-01	1.6E-04	1.0E+00	1.6E-04
tert-Butylbenzene	1.3E-04	2.3E-01	3.0E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-05	2.3E-01	1.5E-05	3.0E+00	4.9E-06
Toluene	6.2E-03	2.3E-01	1.4E-03	5.0E+00	2.8E-04
Hazard Index					**9E+00**

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-3-19
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	2.1E-01	8.2E-02	1.8E-02	N/A	N/A
1,2-Dichlorobenzene	4.1E-04	8.2E-02	3.4E-05	N/A	N/A
1,2-Dichloroethane	2.9E-05	8.2E-02	2.4E-06	2.6E-02	6.2E-08
1,3,5-Trimethylbenzene	1.1E-01	8.2E-02	8.9E-03	N/A	N/A
1,3-Dichlorobenzene	1.6E-04	8.2E-02	1.3E-05	N/A	N/A
1,4-Dichlorobenzene	2.3E-03	8.2E-02	1.9E-04	6.9E-03	1.3E-06
4-Methyl-2-pentanone	1.4E-03	8.2E-02	1.2E-04	N/A	N/A
Acetone	7.0E-06	8.2E-02	5.8E-07	N/A	N/A
Benzene	9.8E-03	8.2E-02	8.1E-04	7.8E-03	6.3E-06
Chlorobenzene	1.7E-02	8.2E-02	1.4E-03	N/A	N/A
Ethylbenzene	1.6E+00	8.2E-02	1.3E-01	N/A	N/A
Isopropylbenzene	1.3E-02	8.2E-02	1.1E-03	N/A	N/A
Methyl tert butyl ether	1.2E-04	8.2E-02	9.5E-06	N/A	N/A
Naphthalene	1.2E-03	8.2E-02	9.7E-05	N/A	N/A
n-Butylbenzene	7.5E-03	8.2E-02	6.2E-04	N/A	N/A
n-Propylbenzene	1.2E-02	8.2E-02	1.0E-03	N/A	N/A
o-Xylene	1.3E-01	8.2E-02	1.1E-02	N/A	N/A
p/m-Xylene	3.6E-01	8.2E-02	3.0E-02	N/A	N/A
p-Isopropyltoluene	2.2E-02	8.2E-02	1.8E-03	N/A	N/A
sec-Butylbenzene	1.4E-07	8.2E-02	1.1E-08	N/A	N/A
Styrene	7.0E-04	8.2E-02	5.8E-05	5.7E-04	3.3E-08
tert-Butylbenzene	1.3E-04	8.2E-02	1.1E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-05	8.2E-02	5.3E-06	N/A	N/A
Toluene	6.2E-03	8.2E-02	5.1E-04	N/A	N/A
Cancer Risk					8E-06

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

Table A-3-7
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Methyl tert butyl ether	3.1E-05	2.3E-01	7.1E-06	3.0E+00	2.4E-06
Hazard Index					2E-06

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-3-8
Current Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Methyl tert butyl ether	3.1E-05	8.2E-02	2.6E-06	N/A	N/A
Cancer Risk					N/A

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

Table A-3-9
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	3.2E-01	2.3E-01	7.3E-02	7.0E-03	**1.0E+01**
1,2-Dichlorobenzene	4.1E-04	2.3E-01	9.4E-05	2.0E-01	4.7E-04
1,2-Dichloroethane	2.9E-05	2.3E-01	6.7E-06	7.0E-03	9.5E-04
1,3,5-Trimethylbenzene	1.1E-01	2.3E-01	2.5E-02	N/A	N/A
1,3-Dichlorobenzene	1.6E-04	2.3E-01	3.7E-05	2.0E-01	1.8E-04
1,4-Dichlorobenzene	2.3E-03	2.3E-01	5.3E-04	8.0E-01	6.6E-04
4-Methyl-2-pentanone	1.4E-03	2.3E-01	3.3E-04	3.0E+00	1.1E-04
Acetone	7.0E-06	2.3E-01	1.6E-06	8.0E-01	2.0E-06
Benzene	9.8E-03	2.3E-01	2.2E-03	3.0E-02	7.5E-02
Chlorobenzene	7.7E-02	2.3E-01	1.7E-02	5.0E-02	3.5E-01
Ethylbenzene	1.6E+00	2.3E-01	3.6E-01	1.0E+00	3.6E-01
Isopropylbenzene	1.3E-02	2.3E-01	3.1E-03	4.0E-01	7.7E-03
Methyl tert butyl ether	1.2E-04	2.3E-01	2.6E-05	3.0E+00	8.8E-06
Naphthalene	1.2E-03	2.3E-01	2.7E-04	3.0E-03	9.0E-02
n-Butylbenzene	7.5E-03	2.3E-01	1.7E-03	N/A	N/A
n-Propylbenzene	1.2E-02	2.3E-01	2.8E-03	1.0E+00	2.8E-03
o-Xylene	1.3E-01	2.3E-01	3.0E-02	1.0E-01	3.0E-01
p/m-Xylene	6.8E-01	2.3E-01	1.5E-01	1.0E-01	**1.5E+00**
p-Isopropyltoluene	2.2E-02	2.3E-01	5.1E-03	4.0E-01	1.3E-02
sec-Butylbenzene	1.4E-07	2.3E-01	3.1E-08	N/A	N/A
Styrene	3.9E-03	2.3E-01	8.8E-04	1.0E+00	8.8E-04
tert-Butylbenzene	1.3E-04	2.3E-01	3.0E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-05	2.3E-01	1.5E-05	3.0E+00	4.9E-06
Toluene	6.2E-03	2.3E-01	1.4E-03	5.0E+00	2.8E-04
Hazard Index					**1E+01**

EXPOSURE ASSUMPTIONS		
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-3-10
Future Land Use Scenario (Former Manufacturing Area) - Industrial Worker
Inhalation of Volatiles from Indoor Air: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	3.2E-01	8.2E-02	2.6E-02	N/A	N/A
1,2-Dichlorobenzene	4.1E-04	8.2E-02	3.4E-05	N/A	N/A
1,2-Dichloroethane	2.9E-05	8.2E-02	2.4E-06	2.6E-02	6.2E-08
1,3,5-Trimethylbenzene	1.1E-01	8.2E-02	8.9E-03	N/A	N/A
1,3-Dichlorobenzene	1.6E-04	8.2E-02	1.3E-05	N/A	N/A
1,4-Dichlorobenzene	2.3E-03	8.2E-02	1.9E-04	6.9E-03	1.3E-06
4-Methyl-2-pentanone	1.4E-03	8.2E-02	1.2E-04	N/A	N/A
Acetone	7.0E-06	8.2E-02	5.8E-07	N/A	N/A
Benzene	9.8E-03	8.2E-02	8.1E-04	7.8E-03	6.3E-06
Chlorobenzene	7.7E-02	8.2E-02	6.3E-03	N/A	N/A
Ethylbenzene	1.6E+00	8.2E-02	1.3E-01	N/A	N/A
Isopropylbenzene	1.3E-02	8.2E-02	1.1E-03	N/A	N/A
Methyl tert butyl ether	1.2E-04	8.2E-02	9.5E-06	N/A	N/A
Naphthalene	1.2E-03	8.2E-02	9.7E-05	N/A	N/A
n-Butylbenzene	7.5E-03	8.2E-02	6.2E-04	N/A	N/A
n-Propylbenzene	1.2E-02	8.2E-02	1.0E-03	N/A	N/A
o-Xylene	1.3E-01	8.2E-02	1.1E-02	N/A	N/A
p/m-Xylene	6.8E-01	8.2E-02	5.6E-02	N/A	N/A
p-Isopropyltoluene	2.2E-02	8.2E-02	1.8E-03	N/A	N/A
sec-Butylbenzene	1.4E-07	8.2E-02	1.1E-08	N/A	N/A
Styrene	3.9E-03	8.2E-02	3.2E-04	5.7E-04	1.8E-07
tert-Butylbenzene	1.3E-04	8.2E-02	1.1E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-05	8.2E-02	5.3E-06	N/A	N/A
Toluene	6.2E-03	8.2E-02	5.1E-04	N/A	N/A
Cancer Risk					8E-06

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	250	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

Table A-4-1
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	9.9E-01	4.1E-07	5.6E-05	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	4.1E-07	9.5E-07	9.0E-01	1.1E-06
1,3,5-Trimethylbenzene	4.6E+01	9.9E-01	4.1E-07	1.9E-05	1.0E-02	1.9E-03
1,4-Dichlorobenzene	1.3E+00	1.0E+00	4.1E-07	5.1E-07	9.0E-01	5.7E-07
2-Butanone	1.0E+01	1.0E+00	4.1E-07	4.3E-06	2.0E+00	2.1E-06
4-Methyl-2-pentanone	8.4E+00	1.0E+00	4.1E-07	3.5E-06	8.0E-01	4.3E-06
	8.7E+00	1.0E+00	4.1E-07	3.6E-06	1.0E+00	3.6E-06
Benzene	8.9E-01	1.0E+00	4.1E-07	3.6E-07	4.0E-03	9.1E-05
Carbon disulfide	1.5E+00	9.9E-01	4.1E-07	6.0E-07	1.0E-01	6.0E-06
Chlorobenzene	1.8E+00	1.0E+00	4.1E-07	7.3E-07	2.0E-01	3.7E-06
Ethylbenzene	8.5E+00	1.0E+00	4.1E-07	3.5E-06	1.0E+00	3.5E-06
Isopropylbenzene	1.9E+00	9.9E-01	4.1E-07	7.8E-07	1.0E-01	7.8E-06
n-Butylbenzene	1.0E+01	9.9E-01	4.1E-07	4.1E-06	5.0E-02	8.1E-05
n-Propylbenzene	4.1E+00	9.9E-01	4.1E-07	1.7E-06	1.0E-01	1.7E-05
Naphthalene	9.5E+00	3.6E-01	1.5E-07	1.4E-06	2.0E-02	7.0E-05
Methyl tert butyl ether	1.1E+00	1.0E+00	4.1E-07	4.3E-07	1.0E+00	4.3E-07
Methylene chloride	5.1E+00	1.0E+00	4.1E-07	2.1E-06	6.0E-02	3.5E-05
o-Xylene	1.1E+01	1.0E+00	4.1E-07	4.5E-06	2.0E-01	2.3E-05
p-Isopropyltoluene	1.7E+00	9.9E-01	4.1E-07	6.7E-07	1.0E-01	6.7E-06
p/m-Xylene	6.2E+01	1.0E+00	4.1E-07	2.5E-05	2.0E-01	1.3E-04
sec-Butylbenzene	1.2E+00	9.9E-01	4.1E-07	4.9E-07	N/A	N/A
Styrene	5.6E+00	1.0E+00	4.1E-07	2.3E-06	2.0E+00	1.1E-06
Toluene	1.9E+00	1.0E+00	4.1E-07	8.0E-07	8.0E-02	1.0E-05
Total Xylenes	1.2E+02	1.0E+00	4.1E-07	5.0E-05	2.0E-01	2.5E-04
2,4-Dimethylphenol	4.2E-01	1.0E+00	4.1E-07	1.7E-07	2.0E-01	8.7E-07
3-Methylphenol/4-Methylphenol	5.5E-01	9.1E-01	3.7E-07	2.0E-07	5.0E-02	4.1E-06
Phenol	1.3E+01	1.0E+00	4.1E-07	5.3E-06	3.0E-01	1.8E-05
2-Methylnaphthalene	1.2E+00	3.6E-01	1.5E-07	1.7E-07	4.0E-03	4.3E-05
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	4.1E-07	1.1E-07	2.0E-02	5.7E-06
Dibenzofuran	3.0E-01	9.1E-01	3.7E-07	1.1E-07	1.0E-03	1.1E-04
Phenanthrene	6.1E-01	3.6E-01	1.5E-07	9.0E-08	3.0E-01	3.0E-07
Arsenic	7.8E+00	1.0E+00	4.1E-07	3.2E-06	3.0E-04	1.1E-02
Barium	2.2E+01	1.0E+00	4.1E-07	9.1E-06	7.0E-02	1.3E-04
Cadmium	4.7E+00	1.0E+00	4.1E-07	1.9E-06	1.0E-03	1.9E-03
Chromium	1.7E+01	1.0E+00	4.1E-07	6.9E-06	2.0E-02	3.5E-04
Copper	1.6E+01	3.9E-01	1.6E-07	2.6E-06	4.0E-02	6.6E-05
Iron	9.5E+03	3.9E-01	1.6E-07	1.5E-03	7.0E-01	2.2E-03
Lead	2.3E+01	5.0E-01	2.1E-07	4.8E-06	7.5E-04	6.3E-03
Silver	3.0E-01	1.0E+00	4.1E-07	1.2E-07	5.0E-03	2.5E-05
Zinc	7.4E+02	1.0E+00	4.1E-07	3.1E-04	3.0E-01	1.0E-03
Hazard Index						3E-02

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-2
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	2.7E-09	3.4E-09	2.4E-02	8.2E-11
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	2.7E-09	2.4E-09	5.5E-02	1.3E-10
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	8.5E+00	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	2.7E-09	1.4E-08	2.0E-03	2.8E-11
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	2.7E-09	1.5E-08	3.0E-02	4.6E-10
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.7E-09	7.5E-10	1.4E-02	1.1E-11
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	2.7E-09	2.1E-08	1.5E+00	3.2E-08
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.7E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.6E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	7.4E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						3E-08

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-3
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.1E-01	4.5E-07	6.2E-05	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E-01	4.1E-07	9.6E-07	9.0E-01	1.1E-06
1,3,5-Trimethylbenzene	4.6E+01	1.1E-01	4.5E-07	2.1E-05	1.0E-02	2.1E-03
1,4-Dichlorobenzene	1.3E+00	1.0E-01	4.1E-07	5.2E-07	9.0E-01	5.7E-07
2-Butanone	1.0E+01	1.0E-01	4.1E-07	4.3E-06	2.0E+00	2.2E-06
4-Methyl-2-pentanone	8.4E+00	1.0E-01	4.1E-07	3.5E-06	8.0E-01	4.3E-06
Acetone	8.7E+00	1.0E-01	4.1E-07	3.6E-06	1.0E+00	3.6E-06
Benzene	8.9E-01	8.0E-02	3.3E-07	2.9E-07	4.0E-03	7.3E-05
Carbon disulfide	1.5E+00	1.1E-01	4.5E-07	6.7E-07	1.0E-01	6.7E-06
Chlorobenzene	1.8E+00	1.0E-01	4.1E-07	7.4E-07	2.0E-01	3.7E-06
Ethylbenzene	8.5E+00	2.0E-01	8.3E-07	7.0E-06	1.0E+00	7.0E-06
Isopropylbenzene	1.9E+00	1.1E-01	4.5E-07	8.7E-07	1.0E-01	8.7E-06
n-Butylbenzene	1.0E+01	1.1E-01	4.5E-07	4.6E-06	5.0E-02	9.1E-05
n-Propylbenzene	4.1E+00	1.1E-01	4.5E-07	1.9E-06	1.0E-01	1.9E-05
Naphthalene	9.5E+00	1.0E-01	4.1E-07	3.9E-06	2.0E-02	2.0E-04
Methyl tert butyl ether	1.1E+00	1.0E-01	4.1E-07	4.4E-07	1.0E+00	4.4E-07
Methylene chloride	5.1E+00	1.0E-01	4.1E-07	2.1E-06	6.0E-02	3.5E-05
o-Xylene	1.1E+01	1.2E-01	5.0E-07	5.4E-06	2.0E-01	2.7E-05
p-Isopropyltoluene	1.7E+00	1.1E-01	4.5E-07	7.5E-07	1.0E-01	7.5E-06
p/m-Xylene	6.2E+01	1.2E-01	5.0E-07	3.1E-05	2.0E-01	1.5E-04
sec-Butylbenzene	1.2E+00	1.1E-01	4.5E-07	5.5E-07	N/A	N/A
Styrene	5.6E+00	2.0E-01	8.3E-07	4.6E-06	2.0E+00	2.3E-06
Toluene	1.9E+00	1.2E-01	5.0E-07	9.7E-07	8.0E-02	1.2E-05
Total Xylenes	1.2E+02	1.2E-01	5.0E-07	6.0E-05	2.0E-01	3.0E-04
2,4-Dimethylphenol	4.2E-01	2.6E-01	1.1E-06	4.6E-07	2.0E-01	2.3E-06
3-Methylphenol/4-Methylphenol	5.5E-01	1.7E-01	7.0E-07	3.8E-07	5.0E-02	7.7E-06
Phenol	1.3E+01	2.6E-01	1.1E-06	1.4E-05	3.0E-01	4.7E-05
2-Methylnaphthalene	1.2E+00	1.0E-01	4.1E-07	4.8E-07	4.0E-03	1.2E-04
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	8.3E-08	2.3E-08	2.0E-02	1.1E-06
Dibenzofuran	3.0E-01	1.7E-01	7.0E-07	2.1E-07	1.0E-03	2.1E-04
Phenanthrene	6.1E-01	1.0E-01	4.1E-07	2.5E-07	3.0E-01	8.4E-07
Arsenic	7.8E+00	3.0E-02	1.2E-07	9.7E-07	3.0E-04	3.2E-03
Barium	2.2E+01	5.0E-02	2.1E-07	4.6E-06	7.0E-02	6.5E-05
Cadmium	4.7E+00	1.4E-01	5.8E-07	2.7E-06	1.0E-03	2.7E-03
Chromium	1.7E+01	9.0E-02	3.7E-07	6.3E-06	2.0E-02	3.1E-04
Copper	1.6E+01	3.0E-02	1.2E-07	2.0E-06	4.0E-02	5.1E-05
Iron	9.5E+03	3.0E-02	1.2E-07	1.2E-03	7.0E-01	1.7E-03
Lead	2.3E+01	6.0E-03	2.5E-08	5.8E-07	7.5E-04	7.7E-04
Silver	3.0E-01	2.5E-01	1.0E-06	3.1E-07	5.0E-03	6.2E-05
Zinc	7.4E+02	2.0E-02	8.3E-08	6.1E-05	3.0E-01	2.0E-04
Hazard Index						1E-02

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-4
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E-01	2.7E-09	3.4E-09	2.4E-02	8.3E-11
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	8.0E-02	2.2E-09	1.9E-09	5.5E-02	1.1E-10
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	8.5E+00	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E-01	2.7E-09	1.4E-08	2.0E-03	2.8E-11
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	2.0E-01	5.5E-09	3.1E-08	3.0E-02	9.2E-10
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	5.5E-10	1.5E-10	1.4E-02	2.1E-12
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	3.0E-02	8.2E-10	6.4E-09	1.5E+00	9.6E-09
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	4.7E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.6E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	7.4E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						1E-08

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-5
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Ingestion of Inhaled Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	9.9E-01	1.2E-05	3.5E-01	4.3E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	2.1E-07	3.5E-01	7.4E-08	9.0E-01	8.2E-08
1,3,5-Trimethylbenzene	4.6E+01	9.9E-01	4.1E-06	3.5E-01	1.4E-06	1.0E-02	1.4E-04
1,4-Dichlorobenzene	1.3E+00	1.0E+00	1.1E-07	3.5E-01	4.0E-08	9.0E-01	4.4E-08
2-Butanone	1.0E+01	1.0E+00	9.4E-07	3.5E-01	3.3E-07	2.0E+00	1.7E-07
4-Methyl-2-pentanone	8.4E+00	1.0E+00	7.6E-07	3.5E-01	2.7E-07	8.0E-01	3.4E-07
Acetone	8.7E+00	1.0E+00	7.8E-07	3.5E-01	2.8E-07	1.0E+00	2.8E-07
Benzene	8.9E-01	1.0E+00	8.0E-08	3.5E-01	2.8E-08	4.0E-03	7.1E-06
Carbon disulfide	1.5E+00	9.9E-01	1.3E-07	3.5E-01	4.7E-08	1.0E-01	4.7E-07
Chlorobenzene	1.8E+00	1.0E+00	1.6E-07	3.5E-01	5.7E-08	2.0E-01	2.8E-07
Ethylbenzene	8.5E+00	1.0E+00	7.6E-07	3.5E-01	2.7E-07	1.0E+00	2.7E-07
Isopropylbenzene	1.9E+00	9.9E-01	1.7E-07	3.5E-01	6.0E-08	1.0E-01	6.0E-07
n-Butylbenzene	1.0E+01	9.9E-01	9.0E-07	3.5E-01	3.2E-07	5.0E-02	6.3E-06
n-Propylbenzene	4.1E+00	9.9E-01	3.7E-07	3.5E-01	1.3E-07	1.0E-01	1.3E-06
Naphthalene	9.5E+00	3.6E-01	8.6E-07	1.3E-01	1.1E-07	2.0E-02	5.5E-06
Methyl tert butyl ether	1.1E+00	1.0E+00	9.5E-08	3.5E-01	3.4E-08	1.0E+00	3.4E-08
Methylene chloride	5.1E+00	1.0E+00	4.6E-07	3.5E-01	1.6E-07	6.0E-02	2.7E-06
o-Xylene	1.1E+01	1.0E+00	9.9E-07	3.5E-01	3.5E-07	2.0E-01	1.8E-06
p-Isopropyltoluene	1.7E+00	9.9E-01	1.5E-07	3.5E-01	5.2E-08	1.0E-01	5.2E-07
p/m-Xylene	6.2E+01	1.0E+00	5.6E-06	3.5E-01	2.0E-06	2.0E-01	9.9E-06
sec-Butylbenzene	1.2E+00	9.9E-01	1.1E-07	3.5E-01	3.8E-08	N/A	N/A
Styrene	5.6E+00	1.0E+00	5.0E-07	3.5E-01	1.8E-07	2.0E+00	8.9E-08
Toluene	1.9E+00	1.0E+00	1.8E-07	3.5E-01	6.2E-08	8.0E-02	7.8E-07
Total Xylenes	1.2E+02	1.0E+00	1.1E-05	3.5E-01	3.9E-06	2.0E-01	1.9E-05
2,4-Dimethylphenol	4.2E-01	1.0E+00	3.8E-08	3.5E-01	1.4E-08	2.0E-01	6.8E-08
3-Methylphenol/4-Methylphenol	5.5E-01	9.1E-01	4.9E-08	3.2E-01	1.6E-08	5.0E-02	3.2E-07
Phenol	1.3E+01	1.0E+00	1.2E-06	3.5E-01	4.1E-07	3.0E-01	1.4E-06
2-Methylnaphthalene	1.2E+00	3.6E-01	1.0E-07	1.3E-01	1.3E-08	4.0E-03	3.3E-06
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.5E-08	3.5E-01	8.8E-09	2.0E-02	4.4E-07
Dibenzofuran	3.0E-01	9.1E-01	2.7E-08	3.2E-01	8.7E-09	1.0E-03	8.7E-06
Phenanthrene	6.1E-01	3.6E-01	5.5E-08	1.3E-01	7.0E-09	3.0E-01	2.3E-08
Arsenic	7.8E+00	1.0E+00	7.0E-07	3.5E-01	2.5E-07	3.0E-04	8.3E-04
Barium	2.2E+01	1.0E+00	2.0E-06	3.5E-01	7.1E-07	7.0E-02	1.0E-05
Cadmium	4.7E+00	1.0E+00	4.2E-07	3.5E-01	1.5E-07	1.0E-03	1.5E-04
Chromium	1.7E+01	1.0E+00	1.5E-06	3.5E-01	5.4E-07	2.0E-02	2.7E-05
Copper	1.6E+01	3.9E-01	1.5E-06	1.4E-01	2.0E-07	4.0E-02	5.1E-06
Iron	9.5E+03	3.9E-01	8.5E-04	1.4E-01	1.2E-04	7.0E-01	1.7E-04
Lead	2.3E+01	5.0E-01	2.1E-06	1.8E-01	3.7E-07	7.5E-04	4.9E-04
Silver	3.0E-01	1.0E+00	2.7E-08	3.5E-01	9.6E-09	5.0E-03	1.9E-06
Zinc	7.4E+02	1.0E+00	6.7E-05	3.5E-01	2.4E-05	3.0E-01	7.9E-05
Hazard Index							2E-03

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-6
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Ingestion of Inhaled Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	1.2E-05	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	2.1E-07	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	4.1E-06	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	1.1E-07	2.4E-03	2.7E-10	2.4E-02	6.4E-12
2-Butanone	1.0E+01	N/A	9.4E-07	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	7.6E-07	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	7.8E-07	N/A	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	8.0E-08	2.4E-03	1.9E-10	5.5E-02	1.0E-11
Carbon disulfide	1.5E+00	N/A	1.3E-07	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	1.6E-07	N/A	N/A	N/A	N/A
Ethylbenzene	8.5E+00	N/A	7.6E-07	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	1.7E-07	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	9.0E-07	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	3.7E-07	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	8.6E-07	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	9.5E-08	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	4.6E-07	2.4E-03	1.1E-09	2.0E-03	2.2E-12
o-Xylene	1.1E+01	N/A	9.9E-07	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	1.5E-07	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	5.6E-06	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	1.1E-07	N/A	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	5.0E-07	2.4E-03	1.2E-09	3.0E-02	3.6E-11
Toluene	1.9E+00	N/A	1.8E-07	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	1.1E-05	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	3.8E-08	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	N/A	4.9E-08	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	1.2E-06	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	1.0E-07	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.5E-08	2.4E-03	5.9E-11	1.4E-02	8.2E-13
Dibenzofuran	3.0E-01	N/A	2.7E-08	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	5.5E-08	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	7.0E-07	2.4E-03	1.7E-09	1.5E+00	2.5E-09
Barium	2.2E+01	N/A	2.0E-06	N/A	N/A	N/A	N/A
Cadmium	4.7E+00	N/A	4.2E-07	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	1.5E-06	N/A	N/A	N/A	N/A
Copper	1.6E+01	N/A	1.5E-06	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	8.5E-04	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	2.1E-06	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	2.7E-08	N/A	N/A	N/A	N/A
Zinc	7.4E+02	N/A	6.7E-05	N/A	N/A	N/A	N/A
Cancer Risk							3E-09

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-7
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	RfC (mg/m^3)	RFD_{Inhal} (mg/kg/day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.0E+00	4.1E-06	3.5E-01	1.5E-06	7.0E-03	2.0E-03	7.3E-04
1,2-Dichlorobenzene	2.3E+00	1.0E+00	6.9E-08	3.5E-01	2.5E-08	2.0E-01	5.7E-02	4.3E-07
1,3,5-Trimethylbenzene	4.6E+01	1.0E+00	1.4E-06	3.5E-01	4.9E-07	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	3.8E-08	3.5E-01	1.3E-08	8.0E-01	2.3E-01	5.8E-08
2-Butanone	1.0E+01	1.0E+00	3.1E-07	3.5E-01	1.1E-07	5.0E+00	1.4E+00	7.8E-08
4-Methyl-2-pentanone	8.4E+00	1.0E+00	2.5E-07	3.5E-01	8.9E-08	3.0E+00	8.6E-01	1.0E-07
Acetone	8.7E+00	1.0E+00	2.6E-07	3.5E-01	9.2E-08	8.0E-01	2.3E-01	4.0E-07
Benzene	8.9E-01	1.0E+00	2.7E-08	3.5E-01	9.4E-09	3.0E-02	8.6E-03	1.1E-06
Carbon disulfide	1.5E+00	1.0E+00	4.5E-08	3.5E-01	1.6E-08	7.0E-01	2.0E-01	7.9E-08
Chlorobenzene	1.8E+00	1.0E+00	5.3E-08	3.5E-01	1.9E-08	5.0E-02	1.4E-02	1.3E-06
Ethylbenzene	8.5E+00	1.0E+00	2.5E-07	3.5E-01	9.0E-08	1.0E+00	2.9E-01	3.2E-07
Isopropylbenzene	1.9E+00	1.0E+00	5.7E-08	3.5E-01	2.0E-08	4.0E-01	1.1E-01	1.8E-07
n-Butylbenzene	1.0E+01	1.0E+00	3.0E-07	3.5E-01	1.1E-07	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	1.0E+00	1.2E-07	3.5E-01	4.4E-08	1.0E+00	2.9E-01	1.5E-07
Naphthalene	9.5E+00	1.0E+00	2.9E-07	3.5E-01	1.0E-07	3.0E-03	8.6E-04	1.2E-04
Methyl tert butyl ether	1.1E+00	1.0E+00	3.2E-08	3.5E-01	1.1E-08	3.0E+00	8.6E-01	1.3E-08
Methylene chloride	5.1E+00	1.0E+00	1.5E-07	3.5E-01	5.4E-08	3.0E+00	8.6E-01	6.4E-08
o-Xylene	1.1E+01	1.0E+00	3.3E-07	3.5E-01	1.2E-07	1.0E-01	2.9E-02	4.1E-06
p-Isopropyltoluene	1.7E+00	1.0E+00	5.0E-08	3.5E-01	1.8E-08	4.0E-01	1.1E-01	1.5E-07
p/m-Xylene	6.2E+01	1.0E+00	1.9E-06	3.5E-01	6.6E-07	1.0E-01	2.9E-02	2.3E-05
sec-Butylbenzene	1.2E+00	1.0E+00	3.6E-08	3.5E-01	1.3E-08	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	1.7E-07	3.5E-01	5.9E-08	3.0E+00	8.6E-01	6.9E-08
Toluene	1.9E+00	1.0E+00	5.8E-08	3.5E-01	2.1E-08	5.0E+00	1.4E+00	1.5E-08
Total Xylenes	1.2E+02	1.0E+00	3.6E-06	3.5E-01	1.3E-06	1.0E-01	2.9E-02	4.5E-05
2,4-Dimethylphenol	4.2E-01	1.0E+00	1.3E-08	3.5E-01	4.5E-09	7.0E-01	2.0E-01	2.3E-08
3-Methylphenol/4-Methylphenol	5.5E-01	1.0E+00	1.6E-08	3.5E-01	5.8E-09	N/A	N/A	N/A
Phenol	1.3E+01	1.0E+00	3.9E-07	3.5E-01	1.4E-07	2.6E-01	7.4E-02	1.9E-06
2-Methylnaphthalene	1.2E+00	1.0E+00	3.5E-08	3.5E-01	1.2E-08	5.0E-01	1.4E-01	8.6E-08
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	8.3E-09	3.5E-01	2.9E-09	7.0E-03	2.0E-03	1.5E-06
Dibenzofuran	3.0E-01	1.0E+00	9.0E-09	3.5E-01	3.2E-09	N/A	N/A	N/A
Phenanthrene	6.1E-01	1.0E+00	1.8E-08	3.5E-01	6.5E-09	5.0E-01	1.4E-01	4.5E-08
Arsenic	7.8E+00	1.0E+00	2.3E-07	3.5E-01	8.3E-08	2.5E-06	7.1E-07	1.2E-01
Barium	2.2E+01	1.0E+00	6.6E-07	3.5E-01	2.4E-07	5.0E-03	1.4E-03	1.6E-04
Cadmium	4.7E+00	1.0E+00	1.4E-07	3.5E-01	5.0E-08	2.0E-05	5.7E-06	8.8E-03
Chromium	1.7E+01	1.0E+00	5.1E-07	3.5E-01	1.8E-07	1.0E-04	2.9E-05	6.3E-03
Copper	1.6E+01	1.0E+00	4.9E-07	3.5E-01	1.7E-07	N/A	N/A	N/A
Iron	9.5E+03	1.0E+00	2.8E-04	3.5E-01	1.0E-04	N/A	N/A	N/A
Lead	2.3E+01	1.0E+00	7.0E-07	3.5E-01	2.5E-07	1.0E-03	2.9E-04	8.6E-04
Silver	3.0E-01	1.0E+00	9.0E-09	3.5E-01	3.2E-09	1.4E-04	4.0E-05	8.0E-05
Zinc	7.4E+02	1.0E+00	2.2E-05	3.5E-01	7.9E-06	1.4E-03	4.0E-04	2.0E-02
Hazard Index								2E-01

EXPOSURE ASSUMPTIONS		
Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION
RfD_{inhal} = [RfC *INH (20 m^3/day)] / BW (70 kg)

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-4-8
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	Unit Risk $(mg/m^3)^{-1}$	CSF_{inhal} (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	1.0E+00	4.1E-06	2.4E-03	9.7E-09	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	6.9E-08	2.4E-03	1.6E-10	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	1.0E+00	1.4E-06	2.4E-03	3.2E-09	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	3.8E-08	2.4E-03	8.8E-11	6.9E-03	2.4E-02	2.1E-12
2-Butanone	1.0E+01	1.0E+00	3.1E-07	2.4E-03	7.4E-10	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	1.0E+00	2.5E-07	2.4E-03	5.9E-10	N/A	N/A	N/A
Acetone	8.7E+00	1.0E+00	2.6E-07	2.4E-03	6.1E-10	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	2.7E-08	2.4E-03	6.3E-11	7.8E-03	2.7E-02	1.7E-12
Carbon disulfide	1.5E+00	1.0E+00	4.5E-08	2.4E-03	1.0E-10	N/A	N/A	N/A
Chlorobenzene	1.8E+00	1.0E+00	5.3E-08	2.4E-03	1.3E-10	N/A	N/A	N/A
Ethylbenzene	8.5E+00	1.0E+00	2.5E-07	2.4E-03	6.0E-10	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	1.0E+00	5.7E-08	2.4E-03	1.3E-10	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	1.0E+00	3.0E-07	2.4E-03	7.1E-10	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	1.0E+00	1.2E-07	2.4E-03	2.9E-10	N/A	N/A	N/A
Naphthalene	9.5E+00	1.0E+00	2.9E-07	2.4E-03	6.7E-10	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	1.0E+00	3.2E-08	2.4E-03	7.5E-11	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	1.5E-07	2.4E-03	3.6E-10	1.0E-05	3.5E-05	1.3E-14
o-Xylene	1.1E+01	1.0E+00	3.3E-07	2.4E-03	7.8E-10	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	1.0E+00	5.0E-08	2.4E-03	1.2E-10	N/A	N/A	N/A
p/m-Xylene	6.2E+01	1.0E+00	1.9E-06	2.4E-03	4.4E-09	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	1.0E+00	3.6E-08	2.4E-03	8.5E-11	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	1.7E-07	2.4E-03	4.0E-10	5.7E-04	2.0E-03	7.9E-13
Toluene	1.9E+00	1.0E+00	5.8E-08	2.4E-03	1.4E-10	N/A	N/A	N/A
Total Xylenes	1.2E+02	1.0E+00	3.6E-06	2.4E-03	8.5E-09	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	1.0E+00	1.3E-08	2.4E-03	3.0E-11	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	5.5E-01	1.0E+00	1.6E-08	2.4E-03	3.9E-11	N/A	N/A	N/A
Phenol	1.3E+01	1.0E+00	3.9E-07	2.4E-03	9.2E-10	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	1.0E+00	3.5E-08	2.4E-03	8.2E-11	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	8.3E-09	2.4E-03	2.0E-11	1.3E-03	4.6E-03	8.9E-14
Dibenzofuran	3.0E-01	1.0E+00	9.0E-09	2.4E-03	2.1E-11	N/A	N/A	N/A
Phenanthrene	6.1E-01	1.0E+00	1.8E-08	2.4E-03	4.3E-11	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	2.3E-07	2.4E-03	5.5E-10	4.3E+00	1.5E+01	8.3E-09
Barium	2.2E+01	1.0E+00	6.6E-07	2.4E-03	1.6E-09	N/A	N/A	N/A
Cadmium	4.7E+00	1.0E+00	1.4E-07	2.4E-03	3.3E-10	1.8E+00	6.3E+00	2.1E-09
Chromium	1.7E+01	1.0E+00	5.1E-07	2.4E-03	1.2E-09	1.2E+01	4.2E+01	5.0E-08
Copper	1.6E+01	1.0E+00	4.9E-07	2.4E-03	1.2E-09	N/A	N/A	N/A
Iron	9.5E+03	1.0E+00	2.8E-04	2.4E-03	6.7E-07	N/A	N/A	N/A
Lead	2.3E+01	1.0E+00	7.0E-07	2.4E-03	1.6E-09	N/A	N/A	N/A
Silver	3.0E-01	1.0E+00	9.0E-09	2.4E-03	2.1E-11	N/A	N/A	N/A
Zinc	7.4E+02	1.0E+00	2.2E-05	2.4E-03	5.3E-08	N/A	N/A	N/A
Cancer Risk								6E-08

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION

CSF_{inhal} = [CSF_{oral} * BW (70 kg)] / INH (20 m^3/day)

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-4-9
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	6.9E-04	2.4E-01	1.6E-04	7.0E-03	2.3E-02
1,2-Dichlorobenzene	2.3E+00	1.4E+04	1.0E-05	2.4E-01	2.4E-06	2.0E-01	1.2E-05
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	2.2E-04	2.4E-01	5.3E-05	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	6.2E-06	2.4E-01	1.5E-06	8.0E-01	1.8E-06
2-Butanone	1.0E+01	1.3E+04	4.9E-05	2.4E-01	1.2E-05	5.0E+00	2.3E-06
4-Methyl-2-pentanone	8.4E+00	9.9E+03	5.1E-05	2.4E-01	1.2E-05	3.0E+00	4.1E-06
Acetone	8.7E+00	1.2E+04	4.4E-05	2.4E-01	1.1E-05	8.0E-01	1.3E-05
Benzene	8.9E-01	2.6E+03	2.1E-05	2.4E-01	4.9E-06	3.0E-02	1.6E-04
Carbon disulfide	1.5E+00	1.1E+03	7.9E-05	2.4E-01	1.9E-05	7.0E-01	2.7E-05
Chlorobenzene	1.8E+00	5.9E+03	1.8E-05	2.4E-01	4.3E-06	5.0E-02	8.7E-05
Ethylbenzene	8.5E+00	5.1E+03	1.0E-04	2.4E-01	2.4E-05	1.0E+00	2.4E-05
Isopropylbenzene	1.9E+00	1.0E+03	1.1E-04	2.4E-01	2.7E-05	4.0E-01	6.7E-05
n-Butylbenzene	1.0E+01	7.7E+03	7.8E-05	2.4E-01	1.9E-05	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	4.1E-05	2.4E-01	9.8E-06	1.0E+00	9.8E-06
Naphthalene	9.5E+00	5.2E+04	1.1E-05	2.4E-01	2.6E-06	3.0E-03	8.6E-04
Methyl tert butyl ether	1.1E+00	3.9E+03	1.6E-05	2.4E-01	3.9E-06	3.0E+00	1.3E-06
Methylene chloride	5.1E+00	2.3E+03	1.3E-04	2.4E-01	3.1E-05	3.0E+00	1.0E-05
o-Xylene	1.1E+01	5.8E+03	1.1E-04	2.4E-01	2.7E-05	1.0E-01	2.7E-04
p-Isopropyltoluene	1.7E+00	1.0E+03	9.7E-05	2.4E-01	2.3E-05	4.0E-01	5.8E-05
p/m-Xylene	6.2E+01	5.2E+03	7.1E-04	2.4E-01	1.7E-04	1.0E-01	1.7E-03
sec-Butylbenzene	1.2E+00	7.0E+03	1.0E-05	2.4E-01	2.4E-06	N/A	N/A
Styrene	5.6E+00	1.3E+04	2.7E-05	2.4E-01	6.3E-06	3.0E+00	2.1E-06
Toluene	1.9E+00	3.7E+03	3.1E-05	2.4E-01	7.5E-06	5.0E+00	1.5E-06
Total Xylenes	1.2E+02	5.2E+03	1.4E-03	2.4E-01	3.3E-04	1.0E-01	3.3E-03
Hazard Index							3E-02

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-4-10
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	6.9E-04	1.6E-03	1.1E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.4E+04	1.0E-05	1.6E-03	1.6E-08	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	2.2E-04	1.6E-03	3.5E-07	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	6.2E-06	1.6E-03	9.8E-09	6.9E-03	6.7E-11
2-Butanone	1.0E+01	1.3E+04	4.9E-05	1.6E-03	7.7E-08	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	9.9E+03	5.1E-05	1.6E-03	8.1E-08	N/A	N/A
Acetone	8.7E+00	1.2E+04	4.4E-05	1.6E-03	7.0E-08	N/A	N/A
Benzene	8.9E-01	2.6E+03	2.1E-05	1.6E-03	3.3E-08	7.8E-03	2.6E-10
Carbon disulfide	1.5E+00	1.1E+03	7.9E-05	1.6E-03	1.3E-07	N/A	N/A
Chlorobenzene	1.8E+00	5.9E+03	1.8E-05	1.6E-03	2.9E-08	N/A	N/A
Ethylbenzene	8.5E+00	5.1E+03	1.0E-04	1.6E-03	1.6E-07	N/A	N/A
Isopropylbenzene	1.9E+00	1.0E+03	1.1E-04	1.6E-03	1.8E-07	N/A	N/A
n-Butylbenzene	1.0E+01	7.7E+03	7.8E-05	1.6E-03	1.2E-07	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	4.1E-05	1.6E-03	6.5E-08	N/A	N/A
Naphthalene	9.5E+00	5.2E+04	1.1E-05	1.6E-03	1.7E-08	N/A	N/A
Methyl tert butyl ether	1.1E+00	3.9E+03	1.6E-05	1.6E-03	2.6E-08	N/A	N/A
Methylene chloride	5.1E+00	2.3E+03	1.3E-04	1.6E-03	2.1E-07	1.0E-05	2.1E-12
o-Xylene	1.1E+01	5.8E+03	1.1E-04	1.6E-03	1.8E-07	N/A	N/A
p-Isopropyltoluene	1.7E+00	1.0E+03	9.7E-05	1.6E-03	1.5E-07	N/A	N/A
p/m-Xylene	6.2E+01	5.2E+03	7.1E-04	1.6E-03	1.1E-06	N/A	N/A
sec-Butylbenzene	1.2E+00	7.0E+03	1.0E-05	1.6E-03	1.6E-08	N/A	N/A
Styrene	5.6E+00	1.3E+04	2.7E-05	1.6E-03	4.2E-08	5.7E-04	2.4E-11
Toluene	1.9E+00	3.7E+03	3.1E-05	1.6E-03	5.0E-08	N/A	N/A
Total Xylenes	1.2E+02	5.2E+03	1.4E-03	1.6E-03	2.2E-06	N/A	N/A
Cancer Risk							3E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-4-11
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Groundwater Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	DAevent (mg/cm^2-event)	Exposure Factor (kg/kg-day)	DAD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	4.8E-01	1.1E-01	1.7E-04	1.1E+00	1.9E-04	N/A	N/A
1,2-Dichlorobenzene	8.3E-03	1.0E-01	1.7E-06	9.9E-01	1.7E-06	9.0E-01	1.9E-06
1,2-Dichloroethane	2.9E-03	1.0E-01	5.8E-08	9.9E-01	5.7E-08	2.0E-01	2.9E-07
1,3,5-Trimethylbenzene	1.3E-01	1.1E-01	3.4E-05	1.1E+00	3.7E-05	1.0E-02	3.7E-03
1,3-Dichlorobenzene	8.8E-03	1.0E-01	2.5E-06	9.9E-01	2.5E-06	9.0E-01	2.8E-06
1,4-Dichlorobenzene	1.3E-02	1.0E-01	2.8E-06	9.9E-01	2.8E-06	9.0E-01	3.1E-06
4-Methyl-2-pentanone	3.7E-02	1.0E-01	4.7E-07	9.9E-01	4.7E-07	8.0E-01	5.8E-07
Acetone	2.9E-02	1.0E-01	6.7E-08	9.9E-01	6.6E-08	1.0E+00	6.6E-08
Benzene	5.5E-03	8.0E-02	3.6E-07	7.9E-01	2.9E-07	4.0E-03	7.2E-05
Chlorobenzene	4.4E-02	1.0E-01	5.7E-06	9.9E-01	5.6E-06	2.0E-01	2.8E-05
Ethylbenzene	5.3E-01	2.0E-01	1.1E-04	2.0E+00	2.2E-04	1.0E+00	2.2E-04
Isopropylbenzene	2.2E-02	1.1E-01	6.1E-06	1.1E+00	6.6E-06	1.0E-01	6.6E-05
Methyl tert butyl ether	4.2E-03	1.0E-01	4.2E-08	9.9E-01	4.1E-08	1.0E+00	4.1E-08
Naphthalene	3.1E-02	1.0E-01	6.8E-06	9.9E-01	6.8E-06	2.0E-02	3.4E-04
n-Butylbenzene	6.1E-03	1.1E-01	5.4E-06	1.1E+00	5.9E-06	5.0E-02	1.2E-04
n-Propylbenzene	1.9E-02	1.1E-01	7.5E-06	1.1E+00	8.1E-06	1.0E-01	8.1E-05
o-Xylene	1.2E-01	1.2E-01	2.4E-05	1.2E+00	2.8E-05	2.0E-01	1.4E-04
p/m-Xylene	6.5E-01	1.2E-01	1.5E-04	1.2E+00	1.7E-04	2.0E-01	8.6E-04
p-Isopropyltoluene	1.4E-02	1.1E-01	8.8E-06	1.1E+00	9.5E-06	1.0E-01	9.5E-05
sec-Butylbenzene	4.1E-03	1.1E-01	4.7E-06	1.1E+00	5.1E-06	N/A	N/A
Styrene	5.4E-03	2.0E-01	8.9E-07	2.0E+00	1.8E-06	2.0E+00	8.8E-07
tert-Butylbenzene	2.6E-02	1.1E-01	1.6E-05	1.1E+00	1.7E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-03	1.0E-01	2.4E-07	9.9E-01	2.4E-07	1.0E+00	2.4E-07
Toluene	7.3E-03	1.2E-01	9.9E-07	1.2E+00	1.2E-06	8.0E-02	1.5E-05
2,4-Dichlorophenol	3.0E-03	4.0E-01	3.4E-07	3.9E+00	1.4E-06	3.0E-03	4.5E-04
2,4-Dimethylphenol	4.5E-03	2.6E-01	2.4E-07	2.6E+00	6.1E-07	2.0E-01	3.1E-06
2-Methylnaphthalene	4.3E-04	1.0E-01	1.5E-07	9.9E-01	1.4E-07	4.0E-03	3.6E-05
3-Methylphenol/4-Methylphenol	2.6E-03	1.7E-01	1.1E-07	1.7E+00	1.9E-07	5.0E-02	3.7E-06
Benzo(a)pyrene	2.0E-04	2.0E-02	1.3E-06	2.0E-01	2.5E-07	3.0E-01	8.4E-07
Benzo(b)fluoranthene	2.0E-04	2.0E-02	1.3E-06	2.0E-01	2.6E-07	3.0E-01	8.5E-07
Benzo(ghi)perylene	1.8E-04	1.0E-01	2.2E-06	9.9E-01	2.2E-06	3.0E-01	7.3E-06
Dibenzo(a,h)anthracene	1.8E-04	2.0E-02	1.7E-06	2.0E-01	3.4E-07	3.0E-01	1.1E-06
Fluorene	1.5E-04	1.0E-01	7.4E-09	9.9E-01	7.3E-09	4.0E-01	1.8E-08
Indeno(1,2,3-cd)Pyrene	2.8E-04	2.0E-02	1.8E-06	2.0E-01	3.6E-07	3.0E-01	1.2E-06
Phenanthrene	2.0E-04	1.0E-01	1.6E-07	9.9E-01	1.6E-07	3.0E-01	5.4E-07
Phenol	5.3E-03	2.6E-01	1.1E-07	2.6E+00	2.7E-07	3.0E-01	9.1E-07
Formaldehyde	4.4E-03	1.7E-01	3.4E-08	1.7E+00	5.7E-08	2.0E-01	2.9E-07
Arsenic	5.2E-02	3.0E-02	2.1E-07	3.0E-01	6.1E-08	3.0E-04	2.0E-04
Barium	1.6E-02	5.0E-02	6.3E-08	4.9E-01	3.1E-08	7.0E-02	4.4E-07
Iron	4.3E+00	3.0E-02	1.7E-05	3.0E-01	5.0E-06	7.0E-01	7.2E-06
Manganese	1.2E+00	3.0E-02	4.6E-06	3.0E-01	1.4E-06	1.4E-01	9.8E-06
Zinc	1.9E-02	2.0E-02	4.7E-08	2.0E-01	9.2E-09	3.0E-01	3.1E-08
Hazard Index							6E-03

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)		3,473	(cm^2)
Event Frequency (EV)		1	(event/day)
Relative Absorption Factor (RAF)	chemical-specific		(unitless)
Exposure Frequency (EF)		30	(days/year)
Exposure Duration (ED)		1	(years)
Body Weight (BW)		58	(kg)
Averaging Time (AT)		182	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = DAD / RfD

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table A-4-12
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Groundwater Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	DAevent (mg/cm^2-event)	Exposure Factor (kg/kg-day)	DAD (mg/kg-day)	SF oral (mg/kg-day)$^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	4.8E-01	N/A	1.7E-04	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	8.3E-03	N/A	1.7E-06	N/A	N/A	N/A	N/A
1,2-Dichloroethane	2.9E-03	1.0E-01	5.8E-08	6.6E-03	3.8E-10	9.1E-02	3.5E-11
1,3,5-Trimethylbenzene	1.3E-01	N/A	3.4E-05	N/A	N/A	N/A	N/A
1,3-Dichlorobenzene	8.8E-03	N/A	2.5E-06	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E-02	1.0E-01	2.8E-06	6.6E-03	1.9E-08	2.4E-02	4.5E-10
4-Methyl-2-pentanone	3.7E-02	N/A	4.7E-07	N/A	N/A	N/A	N/A
Acetone	2.9E-02	N/A	6.7E-08	N/A	N/A	N/A	N/A
Benzene	5.5E-03	8.0E-02	3.6E-07	5.2E-03	1.9E-09	5.5E-02	1.1E-10
Chlorobenzene	4.4E-02	N/A	5.7E-06	N/A	N/A	N/A	N/A
Ethylbenzene	5.3E-01	N/A	1.1E-04	N/A	N/A	N/A	N/A
Isopropylbenzene	2.2E-02	N/A	6.1E-06	N/A	N/A	N/A	N/A
Methyl tert butyl ether	4.2E-03	N/A	4.2E-08	N/A	N/A	N/A	N/A
Naphthalene	3.1E-02	N/A	6.8E-06	N/A	N/A	N/A	N/A
n-Butylbenzene	6.1E-03	N/A	5.4E-06	N/A	N/A	N/A	N/A
n-Propylbenzene	1.9E-02	N/A	7.5E-06	N/A	N/A	N/A	N/A
o-Xylene	1.2E-01	N/A	2.4E-05	N/A	N/A	N/A	N/A
p/m-Xylene	6.5E-01	N/A	1.5E-04	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.4E-02	N/A	8.8E-06	N/A	N/A	N/A	N/A
sec-Butylbenzene	4.1E-03	N/A	4.7E-06	N/A	N/A	N/A	N/A
Styrene	5.4E-03	2.0E-01	8.9E-07	1.3E-02	1.2E-08	3.0E-02	3.5E-10
tert-Butylbenzene	2.6E-02	N/A	1.6E-05	N/A	N/A	N/A	N/A
Tertiary-Amyl Methyl Ether	6.5E-03	N/A	2.4E-07	N/A	N/A	N/A	N/A
Toluene	7.3E-03	N/A	9.9E-07	N/A	N/A	N/A	N/A
2,4-Dichlorophenol	3.0E-03	N/A	3.4E-07	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.5E-03	N/A	2.4E-07	N/A	N/A	N/A	N/A
2-Methylnaphthalene	4.3E-04	N/A	1.5E-07	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.6E-03	N/A	1.1E-07	N/A	N/A	N/A	N/A
Benzo(a)pyrene	2.0E-04	2.0E-02	1.3E-06	1.3E-03	1.7E-09	7.3E+00	1.2E-08
Benzo(b)fluoranthene	2.0E-04	2.0E-02	1.3E-06	1.3E-03	1.7E-09	7.3E-01	1.2E-09
Benzo(ghi)perylene	1.8E-04	N/A	2.2E-06	N/A	N/A	N/A	N/A
Dibenzo(a,h)anthracene	1.8E-04	2.0E-02	1.7E-06	1.3E-03	2.3E-09	7.3E+00	1.7E-08
Fluorene	1.5E-04	N/A	7.4E-09	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)Pyrene	2.8E-04	2.0E-02	1.8E-06	1.3E-03	2.4E-09	7.3E-01	1.8E-09
Phenanthrene	2.0E-04	N/A	1.6E-07	N/A	N/A	N/A	N/A
Phenol	5.3E-03	N/A	1.1E-07	N/A	N/A	N/A	N/A
Formaldehyde	4.4E-03	N/A	3.4E-08	N/A	N/A	N/A	N/A
Arsenic	5.2E-02	3.0E-02	2.1E-07	2.0E-03	4.1E-10	1.5E+00	6.1E-10
Barium	1.6E-02	N/A	6.3E-08	N/A	N/A	N/A	N/A
Iron	4.3E+00	N/A	1.7E-05	N/A	N/A	N/A	N/A
Manganese	1.2E+00	N/A	4.6E-06	N/A	N/A	N/A	N/A
Zinc	1.9E-02	N/A	4.7E-08	N/A	N/A	N/A	N/A
Cancer Risk							3E-08

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3,473	(cm^2)
Event Frequency (EV)	1	(event/day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Frequency (EF)	30	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = DAD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-12.Supplement A
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Groundwater Dermal Contact
Reichhold, Inc., Andover, Massachusetts

Chemical of Potential Concern	Groundwater Concentration (CW) (ug/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
1,2,4-Trimethylbenzene	4.82E+02	8.4E-02	3.5E-01	5.0E-01	1.2E+00	1.0E+00	4.0	1.7E-04	3
1,2-Dichlorobenzene	8.30E+00	4.1E-02	1.9E-01	7.1E-01	1.7E+00	1.0E+00	4.0	1.7E-06	3
1,2-Dichloroethane	2.93E+00	4.2E-03	1.6E-02	3.8E-01	9.2E-01	1.0E+00	4.0	5.8E-08	3
1,3,5-Trimethylbenzene	1.26E+02	6.1E-02	2.6E-01	5.0E-01	1.2E+00	1.0E+00	4.0	3.4E-05	3
1,3-Dichlorobenzene	8.84E+00	5.8E-02	2.7E-01	7.1E-01	1.7E+00	1.0E+00	4.0	2.5E-06	3
1,4-Dichlorobenzene	1.34E+01	4.2E-02	2.0E-01	7.1E-01	1.7E+00	1.0E+00	4.0	2.8E-06	3
4-Methyl-2-pentanone	3.74E+01	2.7E-03	1.0E-02	3.9E-01	9.3E-01	1.0E+00	4.0	4.7E-07	3
Acetone	2.89E+01	5.2E-04	1.5E-03	2.2E-01	5.3E-01	1.0E+00	4.0	6.7E-08	3
Benzene	5.54E+00	1.5E-02	5.1E-02	2.9E-01	7.0E-01	1.0E+00	4.0	3.6E-07	3
Chlorobenzene	4.37E+01	2.8E-02	1.2E-01	4.6E-01	1.1E+00	1.0E+00	4.0	5.7E-06	3
Ethylbenzene	5.32E+02	4.9E-02	2.0E-01	4.2E-01	1.0E+00	1.0E+00	4.0	1.1E-04	3
Isopropylbenzene	2.16E+01	6.4E-02	2.7E-01	4.9E-01	1.2E+00	1.0E+00	4.0	6.1E-06	3
Methyl tert butyl ether	4.23E+00	2.1E-03	7.7E-03	3.3E-01	7.9E-01	1.0E+00	4.0	4.2E-08	3
Naphthalene	3.15E+01	4.7E-02	2.0E-01	5.6E-01	1.3E+00	1.0E+00	4.0	6.8E-06	3
n-Butylbenzene	6.08E+00	2.2E-01	9.7E-01	5.9E-01	2.3E+00	1.0E+00	4.0	5.4E-06	3
n-Propylbenzene	1.93E+01	9.2E-02	3.9E-01	5.0E-01	1.2E+00	1.0E+00	4.0	7.5E-06	3
o-Xylene	1.16E+02	4.7E-02	1.9E-01	4.1E-01	9.9E-01	1.0E+00	4.0	2.4E-05	3
p/m-Xylene	6.47E+02	5.2E-02	2.1E-01	4.1E-01	9.9E-01	1.0E+00	4.0	1.5E-04	3
p-Isopropyltoluene	1.44E+01	1.4E-01	6.4E-01	5.9E-01	2.4E+00	1.0E+00	4.0	8.8E-06	3
sec-Butylbenzene	4.08E+00	2.9E-01	1.3E+00	5.9E-01	2.3E+00	1.0E+00	4.0	4.7E-06	3
Styrene	5.39E+00	3.7E-02	1.5E-01	4.1E-01	9.8E-01	1.0E+00	4.0	8.9E-07	3
tert-Butylbenzene	2.58E+01	1.4E-01	6.5E-01	5.9E-01	2.3E+00	1.0E+00	4.0	1.6E-05	3
Tertiary-Amyl Methyl Ether	6.47E+00	7.9E-03	3.1E-02	3.9E-01	9.4E-01	1.0E+00	4.0	2.4E-07	3
Toluene	7.31E+00	3.1E-02	1.1E-01	3.5E-01	8.4E-01	1.0E+00	4.0	9.9E-07	3
2,4-Dichlorophenol	3.00E+00	2.1E-02	1.0E-01	8.7E-01	2.1E+00	1.0E+00	4.0	3.4E-07	3
2,4-Dimethylphenol	4.48E+00	1.1E-02	4.6E-02	5.2E-01	1.2E+00	1.0E+00	4.0	2.4E-07	3
2-Methylnaphthalene	4.25E-01	7.2E-02	3.3E-01	6.6E-01	1.6E+00	1.0E+00	4.0	1.5E-07	3
3-Methylphenol/4-Methylphenol	2.59E+00	9.0E-03	3.6E-02	4.2E-01	1.0E+00	1.0E+00	4.0	1.1E-07	3
Benzo(a)pyrene	2.00E-01	7.0E-01	4.3E+00	2.7E+00	1.2E+01	1.0E+00	4.0	1.3E-06	2
Benzo(b)fluoranthene	2.00E-01	7.0E-01	4.3E+00	2.8E+00	1.2E+01	1.0E+00	4.0	1.3E-06	2
Benzo(ghi)perylene	1.75E-01	1.2E+00	7.6E+00	3.7E+00	1.7E+01	1.0E+00	4.0	2.2E-06	2
Dibenzo(a,h)anthracene	1.75E-01	1.5E+00	9.7E+00	3.9E+00	1.8E+01	6.0E-01	4.0	1.7E-06	2
Fluorene	1.50E-01	7.8E-03	4.1E-02	1.2E+00	2.8E+00	1.0E+00	4.0	7.4E-09	3
Indeno(1,2,3-cd)Pyrene	2.75E-01	1.0E+00	6.7E+00	3.8E+00	1.7E+01	6.0E-01	4.0	1.8E-06	2
Phenanthrene	2.00E-01	1.4E-01	7.4E-01	1.1E+00	4.1E+00	1.0E+00	4.0	1.6E-07	2
Phenol	5.26E+00	4.3E-03	1.6E-02	3.6E-01	8.6E-01	1.0E+00	4.0	1.1E-07	3
Formaldehyde	4.39E+00	1.8E-03	3.8E-03	1.6E-01	3.8E-01	1.0E+00	4.0	3.4E-08	3
Arsenic	5.16E+01	1.0E-03	NA	NA	NA	NA	4.0	2.1E-07	1
Barium	1.58E+01	1.0E-03	NA	NA	NA	NA	4.0	6.3E-08	1
Iron	4.26E+03	1.0E-03	NA	NA	NA	NA	4.0	1.7E-05	1
Manganese	1.15E+03	1.0E-03	NA	NA	NA	NA	4.0	4.6E-06	1
Zinc	1.95E+01	6.0E-04	NA	NA	NA	NA	4.0	4.7E-08	1

Inorganics: DAevent (mg/cm2-event) =

DA_{event} = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (Eq 1)

Organics: DAevent (mg/cm2-event) =

DA_{event} = t_{event}<t*: DA_{event} (mg/cm^2-event) =
2 x FA x Kp x Cw x (sqrt((6 x τ x t_{event}) / (3.1415))) x CF1 x CF2 (Eq 2)

t_{event}>t*: DA_{event} (mg/cm^2-event) =
FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x ((1 + 3B + $3B^2$)/$(1+B)^2$)) xCF1 x CF2 (Eq 3)

Notes:
NA - Not applicable
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).
t* - Time to reach steady-state

Table A-4-12.Supplement B
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Groundwater Dermal Contact
Reichhold, Inc., Andover, Massachusetts

Chemical	MW[a]	log Kow[a]	Kow	log Kp[b]	Kp (cm/hr)	B[b]	log D_{sc}/l_{sc}[b]	D_{sc}/l_{sc}[b]	l_{sc} (cm)	D_{sc} (cm^2/hr)	τ_{event}[b] (hr)	t*[b] (hr)
1,2,4-Trimethylbenzene	1.20E+02	3.63E+00	4.27E+03	-1.08E+00	8.37E-02	3.53E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
1,3,5-Trimethylbenzene	1.20E+02	3.42E+00	2.63E+03	-1.22E+00	6.08E-02	2.56E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
2-Methylnaphthalene	1.42E+02	3.86E+00	7.24E+03	-1.05E+00	8.96E-02	4.11E-01	-3.60E+00	2.54E-04	1.00E-03	2.54E-07	6.56E-01	1.57E+00
3&4-Methylphenol	1.08E+02	1.94E+00	8.71E+01	-2.13E+00	7.50E-03	3.00E-02	-3.41E+00	3.93E-04	1.00E-03	3.93E-07	4.24E-01	1.02E+00
Acetone	5.81E+01	-2.40E-01	5.75E-01	-3.28E+00	5.20E-04	1.53E-03	-3.13E+00	7.49E-04	1.00E-03	7.49E-07	2.22E-01	5.34E-01
Benzo(g,h,i)perylene	2.76E+02	6.63E+00	4.27E+06	3.02E-02	1.07E+00	6.85E+00	-4.35E+00	4.51E-05	1.00E-03	4.51E-08	3.69E+00	1.65E+01
Fluorene	1.66E+02	4.18E+00	1.51E+04	-9.72E-01	1.07E-01	5.29E-01	-3.73E+00	1.86E-04	1.00E-03	1.86E-07	8.97E-01	2.15E+00
Isopropylbenzene (Cumene)	1.20E+02	3.66E+00	4.57E+03	-1.06E+00	8.76E-02	3.69E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
Methyl tert butyl ether	8.82E+01	9.40E-01	8.71E+00	-2.67E+00	2.12E-03	7.66E-03	-3.29E+00	5.09E-04	1.00E-03	5.09E-07	3.28E-01	7.87E-01
n-Butylbenzene	1.34E+02	4.38E+00	2.40E+04	-6.61E-01	2.18E-01	9.73E-01	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.29E+00
n-Propylbenzene	1.20E+02	3.69E+00	4.90E+03	-1.04E+00	9.17E-02	3.87E-01	-3.47E+00	3.36E-04	1.00E-03	3.36E-07	4.95E-01	1.19E+00
o-Xylene	1.06E+02	3.12E+00	1.32E+03	-1.34E+00	4.62E-02	1.83E-01	-3.39E+00	4.03E-04	1.00E-03	4.03E-07	4.13E-01	9.92E-01
p-Isopropyltoluene	1.34E+02	4.10E+00	1.26E+04	-8.46E-01	1.43E-01	6.36E-01	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.35E+00
sec-Butylbenzene	1.34E+02	4.57E+00	3.72E+04	-5.35E-01	2.91E-01	1.30E+00	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.33E+00
tert-Butylbenzene	1.34E+02	4.11E+00	1.29E+04	-8.39E-01	1.45E-01	6.46E-01	-3.55E+00	2.81E-04	1.00E-03	2.81E-07	5.94E-01	2.34E+00
Tertiary-Amyl Methyl Ether	1.02E+02	1.92E+00	8.32E+01	-2.11E+00	7.85E-03	3.05E-02	-3.37E+00	4.24E-04	1.00E-03	4.24E-07	3.93E-01	9.42E-01

[a] Values obtained from DermWin, v. 1.43 (EPA, 2000). Available online at http://www.epa.gov/opptintr/exposure/pubs/episuite.htm.

[b] Equations from Risk Assessment Guidance for Superfund Volume 1; Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, EPA/540/R/99/005. July 2004).

Table A-4-13
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Volatiles from Groundwater: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.6E-02	2.7E-02	4.4E-04	7.0E-03	6.3E-02
1,2-Dichlorobenzene	1.5E-03	2.7E-02	4.2E-05	2.0E-01	2.1E-04
1,2-Dichloroethane	6.3E-04	2.7E-02	1.7E-05	7.0E-03	2.5E-03
1,3,5-Trimethylbenzene	5.7E-03	2.7E-02	1.6E-04	N/A	N/A
1,3-Dichlorobenzene	1.6E-03	2.7E-02	4.3E-05	2.0E-01	2.2E-04
1,4-Dichlorobenzene	1.6E-03	2.7E-02	4.3E-05	8.0E-01	5.3E-05
4-Methyl-2-pentanone	3.5E-03	2.7E-02	9.7E-05	3.0E+00	3.2E-05
Acetone	4.6E-03	2.7E-02	1.3E-04	8.0E-01	1.6E-04
Benzene	6.5E-03	2.7E-02	1.8E-04	3.0E-02	6.0E-03
Chlorobenzene	6.0E-04	2.7E-02	1.6E-05	5.0E-02	3.3E-04
Ethylbenzene	8.5E-04	2.7E-02	2.3E-05	1.0E+00	2.3E-05
Isopropylbenzene	2.8E-03	2.7E-02	7.6E-05	4.0E-01	1.9E-04
Methyl tert butyl ether	8.5E-04	2.7E-02	2.3E-05	3.0E+00	7.8E-06
Naphthalene	2.2E-03	2.7E-02	6.1E-05	3.0E-03	2.0E-02
n-Butylbenzene	6.0E-02	2.7E-02	1.6E-03	N/A	N/A
n-Propylbenzene	9.8E-04	2.7E-02	2.7E-05	1.0E+00	2.7E-05
o-Xylene	1.0E-03	2.7E-02	2.9E-05	1.0E-01	2.9E-04
p/m-Xylene	2.8E-03	2.7E-02	7.8E-05	1.0E-01	7.8E-04
p-Isopropyltoluene	6.5E-04	2.7E-02	1.8E-05	4.0E-01	4.5E-05
sec-Butylbenzene	1.0E-03	2.7E-02	2.8E-05	N/A	N/A
Styrene	1.3E-02	2.7E-02	3.7E-04	3.0E+00	1.2E-04
tert-Butylbenzene	5.6E-02	2.7E-02	1.6E-03	N/A	N/A
Tertiary-Amyl Methyl Ether	7.2E-04	2.7E-02	2.0E-05	3.0E+00	6.6E-06
Toluene	6.4E-04	2.7E-02	1.7E-05	5.0E+00	3.5E-06
Hazard Index					9E-02

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	4	(hours/day)
Exposure Frequency (EF)	30	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-4-14
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Volatiles from Groundwater: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.6E-02	1.8E-04	2.9E-06	N/A	N/A
1,2-Dichlorobenzene	1.5E-03	1.8E-04	2.8E-07	N/A	N/A
1,2-Dichloroethane	6.3E-04	1.8E-04	1.2E-07	2.6E-02	3.0E-09
1,3,5-Trimethylbenzene	5.7E-03	1.8E-04	1.0E-06	N/A	N/A
1,3-Dichlorobenzene	1.6E-03	1.8E-04	2.9E-07	N/A	N/A
1,4-Dichlorobenzene	1.6E-03	1.8E-04	2.8E-07	6.9E-03	1.9E-09
4-Methyl-2-pentanone	3.5E-03	1.8E-04	6.5E-07	N/A	N/A
Acetone	4.6E-03	1.8E-04	8.4E-07	N/A	N/A
Benzene	6.5E-03	1.8E-04	1.2E-06	7.8E-03	9.3E-09
Chlorobenzene	6.0E-04	1.8E-04	1.1E-07	N/A	N/A
Ethylbenzene	8.5E-04	1.8E-04	1.5E-07	N/A	N/A
Isopropylbenzene	2.8E-03	1.8E-04	5.1E-07	N/A	N/A
Methyl tert butyl ether	8.5E-04	1.8E-04	1.6E-07	N/A	N/A
Naphthalene	2.2E-03	1.8E-04	4.0E-07	N/A	N/A
n-Butylbenzene	6.0E-02	1.8E-04	1.1E-05	N/A	N/A
n-Propylbenzene	9.8E-04	1.8E-04	1.8E-07	N/A	N/A
o-Xylene	1.0E-03	1.8E-04	1.9E-07	N/A	N/A
p/m-Xylene	2.8E-03	1.8E-04	5.2E-07	N/A	N/A
p-Isopropyltoluene	6.5E-04	1.8E-04	1.2E-07	N/A	N/A
sec-Butylbenzene	1.0E-03	1.8E-04	1.9E-07	N/A	N/A
Styrene	1.3E-02	1.8E-04	2.4E-06	5.7E-04	1.4E-09
tert-Butylbenzene	5.6E-02	1.8E-04	1.0E-05	N/A	N/A
Tertiary-Amyl Methyl Ether	7.2E-04	1.8E-04	1.3E-07	N/A	N/A
Toluene	6.4E-04	1.8E-04	1.2E-07	N/A	N/A
Cancer Risk					2E-08

EXPOSURE ASSUMPTIONS

Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	4	(hours/day)
Exposure Frequency (EF)	30	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

Table A-4-14.Supplement A
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Volatiles from Groundwater
Reichhold, Inc., Andover, Massachusetts

Chemical	Concentration in Water (mg/L)	Concentration in Water (g/m^3) C_L	Dimensionless Henry's Law Constant (H') K_{eq}	Diffusion coefficient in air (cm^2/s) D_a	Diffusion coefficient in water (cm^2/s) D_w	Schmidt Number Sc_g	Effective diameter of source (m) d_e	Liquid-phase mass transfer coef (m/s) k_L	k_G (m/s)	1/K	K (m/s)	E (g/s)	Concentration in Air (mg/m^3) C_{air}
1,2,4-Trimethylbenzene	4.71E-01	4.71E-01	2.34E-01	7.50E-02	7.10E-06	2.01E+00	1.13E+01	2.47E-06	2.31E-03	4.07E+05	2.45E-06	1.16E-04	1.61E-02
1,2-Dichlorobenzene	4.26E-02	4.26E-02	7.79E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.84E+05	2.61E-06	1.11E-05	1.54E-03
1,2-Dichloroethane	1.52E-02	1.52E-02	4.01E-02	1.04E-01	9.90E-06	1.45E+00	1.13E+01	3.08E-06	2.88E-03	3.34E+05	3.00E-06	4.55E-06	6.32E-04
1,3,5-Trimethylbenzene	1.66E-01	1.66E-01	3.16E-01	7.50E-02	7.10E-06	2.01E+00	1.13E+01	2.47E-06	2.31E-03	4.07E+05	2.46E-06	4.07E-05	5.66E-03
1,3-Dichlorobenzene	4.33E-02	4.33E-02	7.79E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.84E+05	2.61E-06	1.13E-05	1.57E-03
1,4-Dichlorobenzene	4.28E-02	4.28E-02	9.96E-02	6.90E-02	7.90E-06	2.19E+00	1.13E+01	2.65E-06	2.19E-03	3.82E+05	2.62E-06	1.12E-05	1.55E-03
4-Methyl-2-pentanone	1.16E-01	1.16E-01	5.74E-03	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	4.56E+05	2.19E-06	2.54E-05	3.53E-03
Acetone	1.63E-01	1.63E-01	1.59E-03	1.24E-01	1.14E-05	1.22E+00	1.13E+01	3.38E-06	3.24E-03	4.90E+05	2.04E-06	3.33E-05	4.62E-03
Benzene	1.55E-01	1.55E-01	2.28E-01	8.80E-02	9.80E-06	1.71E+00	1.13E+01	3.06E-06	2.57E-03	3.29E+05	3.04E-06	4.71E-05	6.55E-03
Chlorobenzene	1.54E-02	1.54E-02	1.52E-01	7.30E-02	8.70E-06	2.07E+00	1.13E+01	2.82E-06	2.27E-03	3.57E+05	2.80E-06	4.32E-06	6.00E-04
Ethylbenzene	2.34E-02	2.34E-02	3.23E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	6.11E-06	8.49E-04
Isopropylbenzene	7.60E-02	7.60E-02	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	1.99E-05	2.77E-03
Methyl tert butyl ether	2.01E-02	2.01E-02	2.40E-02	1.02E-01	1.05E-05	1.47E+00	1.13E+01	3.20E-06	2.85E-03	3.27E+05	3.06E-06	6.14E-06	8.53E-04
Naphthalene	6.63E-02	6.63E-02	1.98E-02	5.90E-02	7.50E-06	2.56E+00	1.13E+01	2.56E-06	1.97E-03	4.17E+05	2.40E-06	1.59E-05	2.21E-03
n-Butylbenzene	1.64E+00	1.64E+00	5.37E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	4.31E-04	5.98E-02
n-Propylbenzene	2.70E-02	2.70E-02	5.37E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	7.07E-06	9.82E-04
o-Xylene	2.45E-02	2.45E-02	2.13E-01	8.70E-02	1.00E-05	1.73E+00	1.13E+01	3.10E-06	2.55E-03	3.25E+05	3.08E-06	7.55E-06	1.05E-03
p/m-Xylene	6.61E-02	6.61E-02	2.13E-01	8.70E-02	1.00E-05	1.73E+00	1.13E+01	3.10E-06	2.55E-03	3.25E+05	3.08E-06	2.04E-05	2.83E-03
p-Isopropyltoluene	1.79E-02	1.79E-02	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	4.69E-06	6.51E-04
sec-Butylbenzene	2.78E-02	2.78E-02	7.67E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.81E+05	2.62E-06	7.30E-06	1.01E-03
Styrene	3.65E-01	3.65E-01	1.13E-01	7.10E-02	8.00E-06	2.12E+00	1.13E+01	2.67E-06	2.23E-03	3.79E+05	2.64E-06	9.64E-05	1.34E-02
tert-Butylbenzene	1.55E+00	1.55E+00	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	4.07E-04	5.65E-02
Tertiary-Amyl Methyl Ether	1.97E-02	1.97E-02	5.17E-01	7.50E-02	7.80E-06	2.01E+00	1.13E+01	2.63E-06	2.31E-03	3.82E+05	2.62E-06	5.15E-06	7.15E-04
Toluene	1.64E-02	1.64E-02	2.72E-01	8.70E-02	8.60E-06	1.73E+00	1.13E+01	2.80E-06	2.55E-03	3.58E+05	2.79E-06	4.58E-06	6.36E-04

Concentration in Air (C_{air}) = (mg/m^3)	**$1000 * E/H * V_{wind} * L$**
Emissions from Liquid surface (E) = (g/s)	**$K * A * C_L$**
Overall Mas Transfer Coefficient (K) = (m/s)	**$1/K = 1/k_L + 1/k_G * K_{eq}$**
Liquid-phase Mass Transfer Coefficient (k_L) = (m/s)	**$2.78E\text{-}06 * (D_w/D_{ether})^{2/3}$**
Gas-phase Mass Transfer Coefficient (k_G) = (m/g)	**$4.82E\text{-}03 * U^{0.78} * Sc_G^{-0.67} * d_e^{-0.11}$**
Effective Diameter of Source (d_e) = (m)	**$(4 * A / \pi)^{0.5}$**
Schmidt Number Calculation (Sc_G) =	**$u_G/p_G * D_a$**

Parameters		**Values**
C_L	Concentration in liquid phase (g/m^3)	chemical specific
K	overall mass transfer coefficient (m/s)	calculated
k_L	liquid-phase mass transfer coefficient (m/s)	calculated
k_G	gas-phase mass transfer coefficient (m/s)	calculated
K_{eq}	Equilibrium constant (Henry's Law constant)	chemical specific
D_{ether}	Diffusion coefficient of ether in water (cm^2/s)	8.50E-06
D_w	Diffusion coefficient in water (cm^2/s)	chemical specific
U	Windspeed (m/s)	1
A	Area of the source (m^2)	100
u_G	viscosity of air (g/cm-s)	1.81E-04
p_G	density of air (g/cm^3)	1.20E-03
D_a	Diffusion coefficient in air (cm^2/s)	chemical specific
H	Height of breathing zone (m)	2
Vwind	Average wind speed in breathing zone (m/s)	2.25
L	Length of breathing zone perpendicular to wind (m)	1.6

Notes: Chemical and physical properties from EPA Region 9 PRG Table (EPA, 2004).
Isopropylbenzene used a surrogate for p-Isopropyltoluene
Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether

Table A-4-15
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Incidental Concrete Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	4.1E-07	1.2E-08	1.0E+00	1.2E-08
p/m-Xylene	4.0E-03	1.0E+00	4.1E-07	1.6E-09	2.0E-01	8.2E-09
Phenol	3.3E+00	1.0E+00	4.1E-07	1.4E-06	3.0E-01	4.5E-06
C19-C36 Aliphatics	3.9E+01	1.0E+00	4.1E-07	1.6E-05	6.0E+00	2.6E-06
Barium	5.8E+01	1.0E+00	4.1E-07	2.4E-05	7.0E-02	3.4E-04
Cadmium	1.2E+00	1.0E+00	4.1E-07	5.0E-07	1.0E-03	5.0E-04
Chromium (Total)	3.5E+01	1.0E+00	4.1E-07	1.4E-05	2.0E-02	7.2E-04
Chromium (III)	4.3E+01	1.0E+00	4.1E-07	1.8E-05	1.0E+00	1.8E-05
Copper	2.9E+01	3.9E-01	1.6E-07	4.7E-06	4.0E-02	1.2E-04
Iron	1.8E+04	3.9E-01	1.6E-07	2.8E-03	7.0E-01	4.0E-03
Zinc	1.1E+02	1.0E+00	4.1E-07	4.7E-05	3.0E-01	1.6E-04
Hazard Index						

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-16
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Incidental Concrete Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-17
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Concrete Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E-01	4.1E-07	1.2E-08	1.0E+00	1.2E-08
p/m-Xylene	4.0E-03	1.2E-01	5.0E-07	2.0E-09	2.0E-01	9.9E-09
Phenol	3.3E+00	2.6E-01	1.1E-06	3.6E-06	3.0E-01	1.2E-05
C19-C36 Aliphatics	3.9E+01	1.0E-01	4.1E-07	1.6E-05	6.0E+00	2.7E-06
Barium	5.8E+01	5.0E-02	2.1E-07	1.2E-05	7.0E-02	1.7E-04
Cadmium	1.2E+00	1.4E-01	5.8E-07	7.0E-07	1.0E-03	7.0E-04
Chromium (Total)	3.5E+01	9.0E-02	3.7E-07	1.3E-05	2.0E-02	6.5E-04
Chromium (III)	4.3E+01	4.0E-01	1.7E-06	7.2E-05	1.0E+00	7.2E-05
Copper	2.9E+01	3.0E-02	1.2E-07	3.6E-06	4.0E-02	9.0E-05
Iron	1.8E+04	3.0E-02	1.2E-07	2.2E-03	7.0E-01	3.1E-03
Zinc	1.1E+02	2.0E-02	8.3E-08	9.5E-06	3.0E-01	3.2E-05
Hazard Index						5E-03

EXPOSURE ASSUMPTIONS		
Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-18
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Concrete Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK
Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-19
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Ingestion of Inhaled Particulates from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	2.6E-09	3.5E-01	9.0E-10	1.0E+00	9.0E-10
p/m-Xylene	4.0E-03	1.0E+00	3.6E-10	3.5E-01	1.3E-10	2.0E-01	6.4E-10
Phenol	3.3E+00	1.0E+00	3.0E-07	3.5E-01	1.1E-07	3.0E-01	3.5E-07
C19-C36 Aliphatics	3.9E+01	1.0E+00	3.5E-06	3.5E-01	1.2E-06	6.0E+00	2.1E-07
Barium	5.8E+01	1.0E+00	5.2E-06	3.5E-01	1.8E-06	7.0E-02	2.6E-05
Cadmium	1.2E+00	1.0E+00	1.1E-07	3.5E-01	3.9E-08	1.0E-03	3.9E-05
Chromium (Total)	3.5E+01	1.0E+00	3.2E-06	3.5E-01	1.1E-06	2.0E-02	5.6E-05
Chromium (III)	4.3E+01	1.0E+00	3.9E-06	3.5E-01	1.4E-06	1.0E+00	1.4E-06
Copper	2.9E+01	3.9E-01	2.6E-06	1.4E-01	3.6E-07	4.0E-02	9.1E-06
Iron	1.8E+04	3.9E-01	1.6E-03	1.4E-01	2.2E-04	7.0E-01	3.1E-04
Zinc	1.1E+02	1.0E+00	1.0E-05	3.5E-01	3.7E-06	3.0E-01	1.2E-05
Hazard Index							5E-04

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-4-20
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Ingestion of Inhaled Particulates from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	2.6E-09	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	3.6E-10	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	3.0E-07	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	3.5E-06	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	5.2E-06	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	1.1E-07	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	3.2E-06	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	3.9E-06	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	2.6E-06	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	1.6E-03	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	1.0E-05	N/A	N/A	N/A	N/A
Cancer Risk							0E+00

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-4-21
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Particulates from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	RfC (mg/m^3)	RFD_{Inhal} (mg/kg/day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	8.5E-10	3.5E-01	3.0E-10	8.0E-01	2.3E-01	1.3E-09
p/m-Xylene	4.0E-03	1.0E+00	1.2E-10	3.5E-01	4.3E-11	1.0E-01	2.9E-02	1.5E-09
Phenol	3.3E+00	1.0E+00	9.9E-08	3.5E-01	3.5E-08	2.6E-01	7.4E-02	4.7E-07
C19-C36 Aliphatics	3.9E+01	1.0E+00	1.2E-06	3.5E-01	4.1E-07	N/A	N/A	N/A
Barium	5.8E+01	1.0E+00	1.7E-06	3.5E-01	6.2E-07	5.0E-03	1.4E-03	4.3E-04
Cadmium	1.2E+00	1.0E+00	3.6E-08	3.5E-01	1.3E-08	2.0E-05	5.7E-06	2.3E-03
Chromium (Total)	3.5E+01	1.0E+00	1.1E-06	3.5E-01	3.7E-07	1.0E-04	2.9E-05	1.3E-02
Chromium (III)	4.3E+01	1.0E+00	1.3E-06	3.5E-01	4.6E-07	3.0E-04	8.6E-05	5.4E-03
Copper	2.9E+01	1.0E+00	8.7E-07	3.5E-01	3.1E-07	N/A	N/A	N/A
Iron	1.8E+04	1.0E+00	5.3E-04	3.5E-01	1.9E-04	N/A	N/A	N/A
Zinc	1.1E+02	1.0E+00	3.4E-06	3.5E-01	1.2E-06	1.4E-03	4.0E-04	3.0E-03
Hazard Index								2E-02

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION
RfD_{inhal} = [RfC *INH (20 m^3/day)] / BW (70 kg)

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-4-22
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Particulates from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	Unit Risk $(mg/m^3)^{-1}$	CSF_{inhal} (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	1.0E+00	8.5E-10	2.4E-03	2.0E-12	N/A	N/A	N/A
p/m-Xylene	4.0E-03	1.0E+00	1.2E-10	2.4E-03	2.8E-13	N/A	N/A	N/A
Phenol	3.3E+00	1.0E+00	9.9E-08	2.4E-03	2.3E-10	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	1.0E+00	1.2E-06	2.4E-03	2.7E-09	N/A	N/A	N/A
Barium	5.8E+01	1.0E+00	1.7E-06	2.4E-03	4.1E-09	N/A	N/A	N/A
Cadmium	1.2E+00	1.0E+00	3.6E-08	2.4E-03	8.6E-11	1.8E-03	6.3E-03	5.4E-13
Chromium (Total)	3.5E+01	1.0E+00	1.1E-06	2.4E-03	2.5E-09	1.2E-02	4.2E-02	1.0E-10
Chromium (III)	4.3E+01	1.0E+00	1.3E-06	2.4E-03	3.1E-09	N/A	N/A	N/A
Copper	2.9E+01	1.0E+00	8.7E-07	2.4E-03	2.1E-09	N/A	N/A	N/A
Iron	1.8E+04	1.0E+00	5.3E-04	2.4E-03	1.2E-06	N/A	N/A	N/A
Zinc	1.1E+02	1.0E+00	3.4E-06	2.4E-03	8.1E-09	N/A	N/A	N/A
Cancer Risk								1E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION

CSF_{inhal} = [CSF_{oral} * BW (70 kg)] / INH (20 m^3/day)

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration

Table A-4-23
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Volatiles from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Acetone	2.8E-02	1.2E+04	1.4E-07	2.4E-01	3.4E-08	8.0E-01	4.3E-08
p/m-Xylene	4.0E-03	5.2E+03	4.6E-08	2.4E-01	1.1E-08	1.0E-01	1.1E-07
Phenol	3.3E+00	N/A	N/A	2.4E-01	N/A	2.6E-01	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	2.4E-01	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	2.4E-01	N/A	5.0E-03	N/A
Cadmium	1.2E+00	N/A	N/A	2.4E-01	N/A	2.0E-05	N/A
Chromium (Total)	3.5E+01	N/A	N/A	2.4E-01	N/A	1.0E-04	N/A
Chromium (III)	4.3E+01	N/A	N/A	2.4E-01	N/A	3.0E-04	N/A
Copper	2.9E+01	N/A	N/A	2.4E-01	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	2.4E-01	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	2.4E-01	N/A	1.4E-03	N/A
Hazard Index							2E-07

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Concrete / VF

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

VF = Volatilization Factor

Table A-4-24
Future Land Use Scenario (Former Manufacturing Area) - Construction Worker
Inhalation of Airborne Volatiles from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Acetone	2.8E-02	1.2E+04	1.4E-07	1.6E-03	2.3E-10	N/A	N/A
p/m-Xylene	4.0E-03	5.2E+03	4.6E-08	1.6E-03	7.3E-11	N/A	N/A
Phenol	3.3E+00	N/A	N/A	1.6E-03	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	1.6E-03	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	1.6E-03	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	1.6E-03	N/A	1.8E-03	N/A
Chromium (Total)	3.5E+01	N/A	N/A	1.6E-03	N/A	1.2E-02	N/A
Chromium (III)	4.3E+01	N/A	N/A	1.6E-03	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	1.6E-03	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	1.6E-03	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	1.6E-03	N/A	N/A	N/A
Cancer Risk							0E+00

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete / VF

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADD_{inhal} =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-5-1
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	2.2E-08	2.5E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	2.2E-08	1.0E-07	1.0E-02	1.0E-05
Acetone	9.2E-01	1.0E+00	2.2E-08	2.0E-08	9.0E-01	2.3E-08
Ethylbenzene	9.2E-01	1.0E+00	2.2E-08	2.0E-08	1.0E-01	2.0E-07
Isopropylbenzene	1.1E-01	9.9E-01	2.2E-08	2.4E-09	1.0E-01	2.4E-08
n-Butylbenzene	1.4E+00	9.9E-01	2.2E-08	3.1E-08	5.0E-02	6.2E-07
n-Propylbenzene	3.7E-01	9.9E-01	2.2E-08	8.3E-09	1.0E-01	8.3E-08
Naphthalene	1.1E+00	3.6E-01	8.0E-09	8.9E-09	2.0E-02	4.5E-07
Methyl tert butyl ether	1.9E-01	1.0E+00	2.2E-08	4.2E-09	1.0E-01	4.2E-08
Methylene chloride	7.1E-01	1.0E+00	2.2E-08	1.6E-08	6.0E-03	2.6E-06
o-Xylene	1.4E+00	1.0E+00	2.2E-08	3.0E-08	2.0E-01	1.5E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	2.2E-08	2.3E-09	1.0E-01	2.3E-08
p/m-Xylene	6.7E+00	1.0E+00	2.2E-08	1.5E-07	2.0E-01	7.5E-07
Total Xylenes	2.2E-01	1.0E+00	2.2E-08	5.0E-09	2.0E-01	2.5E-08
2,4-Dimethylphenol	1.9E-01	1.0E+00	2.2E-08	4.2E-09	2.0E-02	2.1E-07
3-Methylphenol/4-Methylphenol	2.8E-01	9.1E-01	2.0E-08	5.8E-09	5.0E-02	1.2E-07
Phenol	5.6E-01	1.0E+00	2.2E-08	1.2E-08	3.0E-01	4.2E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	2.2E-08	5.9E-09	2.0E-02	2.9E-07
Barium	2.6E+01	1.0E+00	2.2E-08	5.8E-07	2.0E-01	2.9E-06
Cadmium	1.1E+00	1.0E+00	2.2E-08	2.5E-08	1.0E-03	2.5E-05
Copper	2.2E+01	3.9E-01	8.7E-09	1.9E-07	4.0E-02	4.9E-06
Iron	1.0E+04	3.9E-01	8.7E-09	9.0E-05	7.0E-01	1.3E-04
Silver	2.9E-01	1.0E+00	2.2E-08	6.4E-09	5.0E-03	1.3E-06
Zinc	1.3E+02	1.0E+00	2.2E-08	2.9E-06	3.0E-01	9.7E-06
Hazard Index						2E-04

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-5-2
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	8.9E-09	6.3E-09	2.0E-03	1.3E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	8.9E-09	2.4E-09	1.4E-02	3.3E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						5E-11

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-5-3
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	2.0E-08	2.2E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	2.0E-08	9.2E-08	1.0E-02	9.2E-06
Acetone	9.2E-01	1.0E-01	1.8E-08	1.7E-08	9.0E-01	1.8E-08
Ethylbenzene	9.2E-01	2.0E-01	3.6E-08	3.3E-08	1.0E-01	3.3E-07
Isopropylbenzene	1.1E-01	1.1E-01	2.0E-08	2.1E-09	1.0E-01	2.1E-08
n-Butylbenzene	1.4E+00	1.1E-01	2.0E-08	2.8E-08	5.0E-02	5.5E-07
n-Propylbenzene	3.7E-01	1.1E-01	2.0E-08	7.4E-09	1.0E-01	7.4E-08
Naphthalene	1.1E+00	1.0E-01	1.8E-08	2.0E-08	2.0E-02	1.0E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	1.8E-08	3.4E-09	1.0E-01	3.4E-08
Methylene chloride	7.1E-01	1.0E-01	1.8E-08	1.3E-08	6.0E-03	2.1E-06
o-Xylene	1.4E+00	1.2E-01	2.2E-08	2.9E-08	2.0E-01	1.5E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	2.0E-08	2.1E-09	1.0E-01	2.1E-08
p/m-Xylene	6.7E+00	1.2E-01	2.2E-08	1.5E-07	2.0E-01	7.3E-07
Total Xylenes	2.2E-01	1.2E-01	2.2E-08	4.8E-09	2.0E-01	2.4E-08
2,4-Dimethylphenol	1.9E-01	2.6E-01	4.7E-08	8.9E-09	2.0E-02	4.5E-07
3-Methylphenol/4-Methylphenol	2.8E-01	1.7E-01	3.1E-08	8.7E-09	5.0E-02	1.7E-07
Phenol	5.6E-01	2.6E-01	4.7E-08	2.6E-08	3.0E-01	8.8E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	3.6E-09	9.5E-10	2.0E-02	4.8E-08
Barium	2.6E+01	5.0E-02	9.0E-09	2.3E-07	2.0E-01	1.2E-06
Cadmium	1.1E+00	1.4E-01	2.5E-08	2.9E-08	1.0E-03	2.9E-05
Copper	2.2E+01	3.0E-02	5.4E-09	1.2E-07	4.0E-02	3.0E-06
Iron	1.0E+04	3.0E-02	5.4E-09	5.6E-05	7.0E-01	8.0E-05
Silver	2.9E-01	2.5E-01	4.5E-08	1.3E-08	5.0E-03	2.6E-06
Zinc	1.3E+02	2.0E-02	3.6E-09	4.7E-07	3.0E-01	1.6E-06
Hazard Index						1E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-5-4
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	7.2E-09	5.1E-09	2.0E-03	1.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	1.4E-09	3.8E-10	1.4E-02	5.3E-12
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-5-5
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	3.1E-02	2.6E-06	7.0E-03	3.7E-04
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	3.1E-02	2.5E-06	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	3.1E-02	6.2E-06	1.0E+00	6.2E-06
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	3.1E-02	4.0E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	3.1E-02	5.2E-06	1.0E+00	5.2E-06
Naphthalene	1.1E+00	5.2E+04	1.9E-05	3.1E-02	6.0E-07	3.0E-03	2.0E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	3.1E-02	8.0E-06	3.0E+00	2.7E-06
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	3.1E-02	1.3E-05	6.0E-01	2.2E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	3.1E-02	5.4E-06	1.0E-01	5.4E-05
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	3.1E-02	5.9E-06	1.0E-01	5.9E-05
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	3.1E-02	1.9E-10	7.0E-02	2.7E-09
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	3.1E-02	2.8E-10	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	3.1E-02	5.6E-10	2.6E-01	2.2E-09
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	3.1E-02	2.6E-10	7.0E-03	3.8E-08
Barium	2.6E+01	N/A	8.3E-07	3.1E-02	2.6E-08	5.0E-04	5.2E-05
Cadmium	1.1E+00	N/A	3.6E-08	3.1E-02	1.1E-09	2.0E-05	5.7E-05
Copper	2.2E+01	N/A	7.2E-07	3.1E-02	2.2E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	3.1E-02	1.0E-05	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	3.1E-02	2.9E-10	1.4E-04	2.0E-06
Zinc	1.3E+02	N/A	4.2E-06	3.1E-02	1.3E-07	1.4E-03	9.4E-05
Hazard Index							1E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	10,950	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-5-6
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	1.2E-02	1.0E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	1.2E-02	1.0E-06	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	1.2E-02	1.1E-06	N/A	N/A
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	1.2E-02	2.5E-06	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	1.2E-02	1.2E-05	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	1.2E-02	1.6E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	1.2E-02	2.1E-06	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	1.2E-02	2.4E-07	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	1.2E-02	3.2E-06	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	1.2E-02	5.3E-06	1.0E-05	5.3E-11
o-Xylene	1.4E+00	5.8E+03	1.7E-04	1.2E-02	2.2E-06	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	1.2E-02	1.2E-05	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	1.2E-02	2.4E-06	N/A	N/A
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	1.2E-02	2.4E-06	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	1.2E-02	7.6E-11	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	1.2E-02	1.1E-10	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	1.2E-02	2.2E-10	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	1.2E-02	1.1E-10	1.3E-03	1.4E-13
Barium	2.6E+01	N/A	8.3E-07	1.2E-02	1.0E-08	N/A	N/A
Cadmium	1.1E+00	N/A	3.6E-08	1.2E-02	4.5E-10	1.8E+00	8.2E-10
Copper	2.2E+01	N/A	7.2E-07	1.2E-02	9.0E-09	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	1.2E-02	4.1E-06	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	1.2E-02	1.1E-10	N/A	N/A
Zinc	1.3E+02	N/A	4.2E-06	1.2E-02	5.2E-08	N/A	N/A
Cancer Risk							9E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-5-7
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Incidental Concrete Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	2.2E-08	6.3E-10	9.0E-01	7.0E-10
p/m-Xylene	4.0E-03	1.0E+00	2.2E-08	8.9E-11	2.0E-01	4.5E-10
Phenol	3.3E+00	1.0E+00	2.2E-08	7.4E-08	3.0E-01	2.5E-07
C19-C36 Aliphatics	3.9E+01	1.0E+00	2.2E-08	8.6E-07	2.0E+00	4.3E-07
Barium	5.8E+01	1.0E+00	2.2E-08	1.3E-06	2.0E-01	6.4E-06
Cadmium	1.2E+00	1.0E+00	2.2E-08	2.7E-08	1.0E-03	2.7E-05
Chromium (Total)	3.5E+01	1.0E+00	2.2E-08	7.8E-07	3.0E-03	2.6E-04
Chromium (III)	4.3E+01	1.0E+00	2.2E-08	9.6E-07	1.5E+00	6.4E-07
Copper	2.9E+01	3.9E-01	8.7E-09	2.5E-07	4.0E-02	6.3E-06
Iron	1.8E+04	3.9E-01	8.7E-09	1.5E-04	7.0E-01	2.2E-04
Zinc	1.1E+02	1.0E+00	2.2E-08	2.5E-06	3.0E-01	8.5E-06
Hazard Index						5E-04

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD
Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-5-8
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Incidental Concrete Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-5-9
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Concrete Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E-01	1.8E-08	5.1E-10	9.0E-01	5.7E-10
p/m-Xylene	4.0E-03	1.2E-01	2.2E-08	8.6E-11	2.0E-01	4.3E-10
Phenol	3.3E+00	2.6E-01	4.7E-08	1.6E-07	3.0E-01	5.2E-07
C19-C36 Aliphatics	3.9E+01	1.0E-01	1.8E-08	7.0E-07	2.0E+00	3.5E-07
Barium	5.8E+01	5.0E-02	9.0E-09	5.2E-07	2.0E-01	2.6E-06
Cadmium	1.2E+00	1.4E-01	2.5E-08	3.1E-08	1.0E-03	3.1E-05
Chromium (Total)	3.5E+01	9.0E-02	1.6E-08	5.7E-07	3.0E-03	1.9E-04
Chromium (III)	4.3E+01	4.0E-01	7.2E-08	3.1E-06	1.5E+00	2.1E-06
Copper	2.9E+01	3.0E-02	5.4E-09	1.6E-07	4.0E-02	3.9E-06
Iron	1.8E+04	3.0E-02	5.4E-09	9.5E-05	7.0E-01	1.4E-04
Zinc	1.1E+02	2.0E-02	3.6E-09	4.1E-07	3.0E-01	1.4E-06
Hazard Index						4E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-5-10
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Concrete Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-5-11
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Acetone	2.8E-02	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	3.1E-02	5.9E-06	1.0E-01	5.9E-05
Phenol	3.3E+00	N/A	1.1E-07	3.1E-02	3.3E-09	2.6E-01	1.3E-08
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	3.1E-02	3.9E-08	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	3.1E-02	5.8E-08	5.0E-04	1.2E-04
Cadmium	1.2E+00	N/A	3.9E-08	3.1E-02	1.2E-09	2.0E-05	6.0E-05
Chromium (Total)	3.5E+01	N/A	1.1E-06	3.1E-02	3.5E-08	1.0E-04	3.5E-04
Chromium (III)	4.3E+01	N/A	1.4E-06	3.1E-02	4.3E-08	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	3.1E-02	2.9E-08	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	3.1E-02	1.8E-05	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	3.1E-02	1.1E-07	1.4E-03	8.2E-05
Hazard Index							7E-04

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	10,950	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-5-12
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Acetone	2.8E-02	1.2E+04	8.5E-05	1.2E-02	1.1E-06	N/A	N/A
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	1.2E-02	2.4E-06	N/A	N/A
Phenol	3.3E+00	N/A	1.1E-07	1.2E-02	1.3E-09	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	1.2E-02	1.5E-08	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	1.2E-02	2.3E-08	N/A	N/A
Cadmium	1.2E+00	N/A	3.9E-08	1.2E-02	4.8E-10	1.8E-03	8.7E-13
Chromium (Total)	3.5E+01	N/A	1.1E-06	1.2E-02	1.4E-08	1.2E-02	1.7E-10
Chromium (III)	4.3E+01	N/A	1.4E-06	1.2E-02	1.7E-08	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	1.2E-02	1.2E-08	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	1.2E-02	7.0E-06	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	1.2E-02	4.6E-08	N/A	N/A
Cancer Risk							2E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-6-1
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	3.6E-08	4.0E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	3.6E-08	1.7E-07	1.0E-02	1.7E-05
Acetone	9.2E-01	1.0E+00	3.6E-08	3.3E-08	9.0E-01	3.7E-08
Ethylbenzene	9.2E-01	1.0E+00	3.6E-08	3.3E-08	1.0E-01	3.3E-07
Isopropylbenzene	1.1E-01	9.9E-01	3.6E-08	3.9E-09	1.0E-01	3.9E-08
n-Butylbenzene	1.4E+00	9.9E-01	3.6E-08	5.0E-08	5.0E-02	1.0E-06
n-Propylbenzene	3.7E-01	9.9E-01	3.6E-08	1.3E-08	1.0E-01	1.3E-07
Naphthalene	1.1E+00	3.6E-01	1.3E-08	1.5E-08	2.0E-02	7.3E-07
Methyl tert butyl ether	1.9E-01	1.0E+00	3.6E-08	6.8E-09	1.0E-01	6.8E-08
Methylene chloride	7.1E-01	1.0E+00	3.6E-08	2.6E-08	6.0E-03	4.3E-06
o-Xylene	1.4E+00	1.0E+00	3.6E-08	4.9E-08	2.0E-01	2.5E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	3.6E-08	3.8E-09	1.0E-01	3.8E-08
p/m-Xylene	6.7E+00	1.0E+00	3.6E-08	2.4E-07	2.0E-01	1.2E-06
Total Xylenes	2.2E-01	1.0E+00	3.6E-08	8.1E-09	2.0E-01	4.0E-08
2,4-Dimethylphenol	1.9E-01	1.0E+00	3.6E-08	6.9E-09	2.0E-02	3.4E-07
3-Methylphenol/4-Methylphenol	2.8E-01	9.1E-01	3.3E-08	9.4E-09	5.0E-02	1.9E-07
Phenol	5.6E-01	1.0E+00	3.6E-08	2.0E-08	3.0E-01	6.8E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	3.6E-08	9.6E-09	2.0E-02	4.8E-07
Barium	2.6E+01	1.0E+00	3.6E-08	9.4E-07	2.0E-01	4.7E-06
Cadmium	1.1E+00	1.0E+00	3.6E-08	4.1E-08	1.0E-03	4.1E-05
Copper	2.2E+01	3.9E-01	1.4E-08	3.2E-07	4.0E-02	7.9E-06
Iron	1.0E+04	3.9E-01	1.4E-08	1.5E-04	7.0E-01	2.1E-04
Silver	2.9E-01	1.0E+00	3.6E-08	1.0E-08	5.0E-03	2.1E-06
Zinc	1.3E+02	1.0E+00	3.6E-08	4.8E-06	3.0E-01	1.6E-05
Hazard Index						3E-04

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-6-2
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	5.3E-09	3.8E-09	2.0E-03	7.6E-12
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	5.3E-09	1.4E-09	1.4E-02	2.0E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						3E-11

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-6-3
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	1.3E-07	1.4E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	1.3E-07	6.0E-07	1.0E-02	6.0E-05
Acetone	9.2E-01	1.0E-01	1.2E-07	1.1E-07	9.0E-01	1.2E-07
Ethylbenzene	9.2E-01	2.0E-01	2.3E-07	2.1E-07	1.0E-01	2.1E-06
Isopropylbenzene	1.1E-01	1.1E-01	1.3E-07	1.4E-08	1.0E-01	1.4E-07
n-Butylbenzene	1.4E+00	1.1E-01	1.3E-07	1.8E-07	5.0E-02	3.6E-06
n-Propylbenzene	3.7E-01	1.1E-01	1.3E-07	4.8E-08	1.0E-01	4.8E-07
Naphthalene	1.1E+00	1.0E-01	1.2E-07	1.3E-07	2.0E-02	6.5E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	1.2E-07	2.2E-08	1.0E-01	2.2E-07
Methylene chloride	7.1E-01	1.0E-01	1.2E-07	8.3E-08	6.0E-03	1.4E-05
o-Xylene	1.4E+00	1.2E-01	1.4E-07	1.9E-07	2.0E-01	9.5E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	1.3E-07	1.3E-08	1.0E-01	1.3E-07
p/m-Xylene	6.7E+00	1.2E-01	1.4E-07	9.4E-07	2.0E-01	4.7E-06
Total Xylenes	2.2E-01	1.2E-01	1.4E-07	3.1E-08	2.0E-01	1.6E-07
2,4-Dimethylphenol	1.9E-01	2.6E-01	3.0E-07	5.8E-08	2.0E-02	2.9E-06
3-Methylphenol/4-Methylphenol	2.8E-01	1.7E-01	2.0E-07	5.6E-08	5.0E-02	1.1E-06
Phenol	5.6E-01	2.6E-01	3.0E-07	1.7E-07	3.0E-01	5.7E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	2.3E-08	6.2E-09	2.0E-02	3.1E-07
Barium	2.6E+01	5.0E-02	5.8E-08	1.5E-06	2.0E-01	7.5E-06
Cadmium	1.1E+00	1.4E-01	1.6E-07	1.9E-07	1.0E-03	1.9E-04
Copper	2.2E+01	3.0E-02	3.5E-08	7.9E-07	4.0E-02	2.0E-05
Iron	1.0E+04	3.0E-02	3.5E-08	3.6E-04	7.0E-01	5.2E-04
Silver	2.9E-01	2.5E-01	2.9E-07	8.4E-08	5.0E-03	1.7E-05
Zinc	1.3E+02	2.0E-02	2.3E-08	3.1E-06	3.0E-01	1.0E-05
Hazard Index						9E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4,600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD
Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-6-4
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	1.7E-08	1.2E-08	2.0E-03	2.4E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	2.2E-01	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	N/A	N/A	N/A	N/A
Phenol	5.6E-01	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	3.4E-09	9.0E-10	1.4E-02	1.3E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.1E+00	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.3E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						4E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4,600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-6-5
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	3.1E-02	2.6E-06	7.0E-03	3.7E-04
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	3.1E-02	2.5E-06	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	3.1E-02	6.2E-06	1.0E+00	6.2E-06
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	3.1E-02	4.0E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	3.1E-02	5.2E-06	1.0E+00	5.2E-06
Naphthalene	1.1E+00	5.2E+04	1.9E-05	3.1E-02	6.0E-07	3.0E-03	2.0E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	3.1E-02	8.0E-06	3.0E+00	2.7E-06
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	3.1E-02	1.3E-05	6.0E-01	2.2E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	3.1E-02	5.4E-06	1.0E-01	5.4E-05
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	3.1E-02	5.9E-06	1.0E-01	5.9E-05
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	3.1E-02	1.9E-10	7.0E-02	2.7E-09
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	3.1E-02	2.8E-10	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	3.1E-02	5.6E-10	2.6E-01	2.2E-09
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	3.1E-02	2.6E-10	7.0E-03	3.8E-08
Barium	2.6E+01	N/A	8.3E-07	3.1E-02	2.6E-08	5.0E-04	5.2E-05
Cadmium	1.1E+00	N/A	3.6E-08	3.1E-02	1.1E-09	2.0E-05	5.7E-05
Copper	2.2E+01	N/A	7.2E-07	3.1E-02	2.2E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	3.1E-02	1.0E-05	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	3.1E-02	2.9E-10	1.4E-04	2.0E-06
Zinc	1.3E+02	N/A	4.2E-06	3.1E-02	1.3E-07	1.4E-03	9.4E-05
Hazard Index							1E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	4,015	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-6-6
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	4.6E-03	3.8E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	4.6E-03	3.7E-07	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	4.6E-03	3.9E-07	N/A	N/A
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	4.6E-03	9.0E-07	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	4.6E-03	4.5E-06	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	4.6E-03	5.9E-07	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	4.6E-03	7.6E-07	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	4.6E-03	8.7E-08	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	4.6E-03	1.2E-06	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	4.6E-03	2.0E-06	1.0E-05	2.0E-11
o-Xylene	1.4E+00	5.8E+03	1.7E-04	4.6E-03	7.9E-07	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	4.6E-03	4.5E-06	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	4.6E-03	8.7E-07	N/A	N/A
Total Xylenes	2.2E-01	5.2E+03	1.9E-04	4.6E-03	8.7E-07	N/A	N/A
2,4-Dimethylphenol	1.9E-01	N/A	6.1E-09	4.6E-03	2.8E-11	N/A	N/A
3-Methylphenol/4-Methylphenol	2.8E-01	N/A	9.1E-09	4.6E-03	4.2E-11	N/A	N/A
Phenol	5.6E-01	N/A	1.8E-08	4.6E-03	8.2E-11	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	4.6E-03	3.9E-11	1.3E-03	5.0E-14
Barium	2.6E+01	N/A	8.3E-07	4.6E-03	3.8E-09	N/A	N/A
Cadmium	1.1E+00	N/A	3.6E-08	4.6E-03	1.7E-10	1.8E+00	3.0E-10
Copper	2.2E+01	N/A	7.2E-07	4.6E-03	3.3E-09	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	4.6E-03	1.5E-06	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	4.6E-03	4.2E-11	N/A	N/A
Zinc	1.3E+02	N/A	4.2E-06	4.6E-03	1.9E-08	N/A	N/A
Cancer Risk							3E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table A-6-7
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Incidental Concrete Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E+00	3.6E-08	1.0E-09	9.0E-01	1.1E-09
p/m-Xylene	4.0E-03	1.0E+00	3.6E-08	1.4E-10	2.0E-01	7.2E-10
Phenol	3.3E+00	1.0E+00	3.6E-08	1.2E-07	3.0E-01	4.0E-07
C19-C36 Aliphatics	3.9E+01	1.0E+00	3.6E-08	1.4E-06	2.0E+00	7.0E-07
Barium	5.8E+01	1.0E+00	3.6E-08	2.1E-06	2.0E-01	1.0E-05
Cadmium	1.2E+00	1.0E+00	3.6E-08	4.4E-08	1.0E-03	4.4E-05
Chromium (Total)	3.5E+01	1.0E+00	3.6E-08	1.3E-06	3.0E-03	4.2E-04
Chromium (III)	4.3E+01	1.0E+00	3.6E-08	1.6E-06	1.5E+00	1.0E-06
Copper	2.9E+01	3.9E-01	1.4E-08	4.1E-07	4.0E-02	1.0E-05
Iron	1.8E+04	3.9E-01	1.4E-08	2.5E-04	7.0E-01	3.6E-04
Zinc	1.1E+02	1.0E+00	3.6E-08	4.1E-06	3.0E-01	1.4E-05
Hazard Index						9E-04

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-6-8
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Incidental Concrete Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Concrete Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-6-9
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Concrete Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
Acetone	2.8E-02	1.0E-01	1.2E-07	3.3E-09	9.0E-01	3.7E-09
p/m-Xylene	4.0E-03	1.2E-01	1.4E-07	5.6E-10	2.0E-01	2.8E-09
Phenol	3.3E+00	2.6E-01	3.0E-07	1.0E-06	3.0E-01	3.4E-06
C19-C36 Aliphatics	3.9E+01	1.0E-01	1.2E-07	4.5E-06	2.0E+00	2.3E-06
Barium	5.8E+01	5.0E-02	5.8E-08	3.4E-06	2.0E-01	1.7E-05
Cadmium	1.2E+00	1.4E-01	1.6E-07	2.0E-07	1.0E-03	2.0E-04
Chromium (Total)	3.5E+01	9.0E-02	1.1E-07	3.7E-06	3.0E-03	1.2E-03
Chromium (III)	4.3E+01	4.0E-01	4.7E-07	2.0E-05	1.5E+00	1.3E-05
Copper	2.9E+01	3.0E-02	3.5E-08	1.0E-06	4.0E-02	2.5E-05
Iron	1.8E+04	3.0E-02	3.5E-08	6.2E-04	7.0E-01	8.8E-04
Zinc	1.1E+02	2.0E-02	2.3E-08	2.7E-06	3.0E-01	8.9E-06
Hazard Index						2E-03

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4,600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table A-6-10
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Concrete Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
Acetone	2.8E-02	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	4.0E-03	N/A	N/A	N/A	N/A	N/A
Phenol	3.3E+00	N/A	N/A	N/A	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	N/A	N/A	N/A	N/A
Barium	5.8E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium (Total)	3.5E+01	N/A	N/A	N/A	N/A	N/A
Chromium (III)	4.3E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.9E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.8E+04	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						0E+00

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4,600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Concrete Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table A-6-11
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Concrete: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
Acetone	2.8E-02	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	3.1E-02	5.9E-06	1.0E-01	5.9E-05
Phenol	3.3E+00	N/A	1.1E-07	3.1E-02	3.3E-09	2.6E-01	1.3E-08
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	3.1E-02	3.9E-08	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	3.1E-02	5.8E-08	5.0E-04	1.2E-04
Cadmium	1.2E+00	N/A	3.9E-08	3.1E-02	1.2E-09	2.0E-05	6.0E-05
Chromium (Total)	3.5E+01	N/A	1.1E-06	3.1E-02	3.5E-08	1.0E-04	3.5E-04
Chromium (III)	4.3E+01	N/A	1.4E-06	3.1E-02	4.3E-08	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	3.1E-02	2.9E-08	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	3.1E-02	1.8E-05	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	3.1E-02	1.1E-07	1.4E-03	8.2E-05
Hazard Index							7E-04

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	4,015	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table A-6-12
Future Land Use Scenario (Former Manufacturing Area) - Onsite Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Concrete: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
Acetone	2.8E-02	1.2E+04	8.5E-05	4.6E-03	3.9E-07	N/A	N/A
p/m-Xylene	4.0E-03	5.2E+03	1.9E-04	4.6E-03	8.7E-07	N/A	N/A
Phenol	3.3E+00	N/A	1.1E-07	4.6E-03	4.8E-10	N/A	N/A
C19-C36 Aliphatics	3.9E+01	N/A	1.2E-06	4.6E-03	5.7E-09	N/A	N/A
Barium	5.8E+01	N/A	1.9E-06	4.6E-03	8.5E-09	N/A	N/A
Cadmium	1.2E+00	N/A	3.9E-08	4.6E-03	1.8E-10	1.8E-03	3.2E-13
Chromium (Total)	3.5E+01	N/A	1.1E-06	4.6E-03	5.1E-09	1.2E-02	6.2E-11
Chromium (III)	4.3E+01	N/A	1.4E-06	4.6E-03	6.3E-09	N/A	N/A
Copper	2.9E+01	N/A	9.3E-07	4.6E-03	4.3E-09	N/A	N/A
Iron	1.8E+04	N/A	5.6E-04	4.6E-03	2.6E-06	N/A	N/A
Zinc	1.1E+02	N/A	3.7E-06	4.6E-03	1.7E-08	N/A	N/A
Cancer Risk							6E-11

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Concrete * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

APPENDIX B

HHRAA INTAKE/RISK CALCULATIONS (SHAWSHEEN RIVER)

Table B-1-1
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Sediment Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	8.8E-01	1.1E-01	8.3E-08	7.3E-08	N/A	N/A
2-Butanone	7.0E+00	1.0E-01	7.5E-08	5.3E-07	6.0E-01	8.8E-07
Acetone	7.1E+00	1.0E-01	7.5E-08	5.3E-07	9.0E-01	5.9E-07
Carbon disulfide	1.4E+00	1.1E-01	8.3E-08	1.2E-07	1.0E-01	1.2E-06
Chlorobenzene	1.4E+00	1.0E-01	7.5E-08	1.1E-07	2.0E-02	5.3E-06
Ethyl ether	1.4E+00	1.1E-01	8.3E-08	1.2E-07	2.0E-01	5.8E-07
Ethylbenzene	1.7E+01	2.0E-01	1.5E-07	2.6E-06	1.0E-01	2.6E-05
Fluoranthene	4.1E-01	1.0E-01	7.5E-08	3.1E-08	4.0E-02	7.8E-07
Isopropylbenzene	8.0E-01	1.1E-01	8.3E-08	6.6E-08	1.0E-01	6.6E-07
o-Xylene	2.5E+01	1.2E-01	9.0E-08	2.2E-06	2.0E-01	1.1E-05
p/m-Xylene	9.6E+01	1.2E-01	9.0E-08	8.7E-06	2.0E-01	4.3E-05
Barium	3.0E+01	5.0E-02	3.8E-08	1.1E-06	2.0E-01	5.7E-06
Cadmium	1.2E+00	1.4E-01	1.1E-07	1.2E-07	1.0E-03	1.2E-04
Chromium	1.9E+01	9.0E-02	6.8E-08	1.3E-06	3.0E-03	4.2E-04
Copper	1.8E+01	3.0E-02	2.3E-08	4.0E-07	4.0E-02	9.9E-06
Lead	2.7E+01	6.0E-03	4.5E-09	1.2E-07	7.5E-04	1.6E-04
Mercury	1.6E-01	5.0E-02	3.8E-08	5.9E-09	3.0E-04	2.0E-05
Zinc	1.1E+02	2.0E-02	1.5E-08	1.6E-06	3.0E-01	5.3E-06
Hazard Index						8E-04

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	7,006	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Adherence Factor (AF)	1	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-1-2
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Sediment Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	8.8E-01	N/A	N/A	N/A	N/A	N/A
2-Butanone	7.0E+00	N/A	N/A	N/A	N/A	N/A
Acetone	7.1E+00	N/A	N/A	N/A	N/A	N/A
Carbon disulfide	1.4E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
Ethyl ether	1.4E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	1.7E+01	N/A	N/A	N/A	N/A	N/A
Fluoranthene	4.1E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	8.0E-01	N/A	N/A	N/A	N/A	N/A
o-Xylene	2.5E+01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	9.6E+01	N/A	N/A	N/A	N/A	N/A
Barium	3.0E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.9E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.8E+01	N/A	N/A	N/A	N/A	N/A
Lead	2.7E+01	N/A	N/A	N/A	N/A	N/A
Mercury	1.6E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	7,006	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Adherence Factor (AF)	1	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table B-1-3
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Incidental Surface Water Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (L/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
p/m-Xylene	8.0E-04	1.0E+00	5.4E-06	4.3E-09	2.0E-01	2.2E-08
Hazard Index						2E-08

EXPOSURE ASSUMPTIONS

Volume of Surface Water Ingested (VI	50	(ml/day)
Conversion Factor 1 (CF1)	0.042	(day/hour)
Conversion Factor 2 (CF2)	0.001	(L/mL)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-1-4
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Incidental Surface Water Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (L/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
p/m-Xylene	8.0E-04	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Volume of Surface Water Ingested (Vl	50	(ml/day)
Conversion Factor 1 (CF1)	0.042	(day/hour)
Conversion Factor 2 (CF2)	0.001	(L/mL)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table B-1-5
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Surface Water Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
p/m-Xylene	8.0E-04	1.2E-01	2.2E+00	1.7E-07	2.0E-01	8.3E-07
Hazard Index						8E-07

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	7,006	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Event Frequency (EV)	1	(event/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)
Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = DAD / RfD
Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-1-6
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Surface Water Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
p/m-Xylene	8.0E-04	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	7,006	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Event Frequency (EV)	1	(event/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = DAD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Tables B-1-6.Supplement A
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult
Calculation of DAevent
Reichhold, Inc., Andover, Massachusetts

Chemical of Potential Concern	Surface Water Concentration (CW) (ug/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
p/m-Xylene	8.00E-01	5.2E-02	2.1E-01	4.1E-01	9.9E-01	1.0E+00	1.0	7.6E-08	3

Inorganics: DAevent (mg/cm2-event) =

DA_{event} = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (Eq 1)

Organics: DAevent (mg/cm2-event) =

DA_{event} = t_{event}<t*: DA_{event} (mg/cm^2-event) =
2 x FA x Kp x Cw x (sqrt((6 x τ x t_{event}) / (3.1415))) x CF1 x CF2 (Eq 2)

t_{event}>t*: DA_{event} (mg/cm^2-event) =
FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x ((1 + 3B + 3B^2)/(1+B)^2)) xCF1 x CF2 (Eq 3)

Note:
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005.

Table B-1-7
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult Angler
Ingestion of Fish: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+00	9.9E-01	8.2E-05	9.1E-05	N/A	N/A
Ethylbenzene	2.2E+01	1.0E+00	8.3E-05	1.8E-03	1.0E-01	1.8E-02
Isopropylbenzene	1.0E+00	9.9E-01	8.2E-05	8.3E-05	1.0E-01	8.3E-04
o-Xylene	3.1E+01	1.0E+00	8.3E-05	2.6E-03	2.0E-01	1.3E-02
p/m-Xylene	1.2E+02	1.0E+00	8.3E-05	1.0E-02	2.0E-01	5.0E-02
Cadmium	5.2E-02	1.0E+00	8.3E-05	4.3E-06	1.0E-03	4.3E-03
Chromium	2.0E-01	1.0E+00	8.3E-05	1.6E-05	3.0E-03	5.5E-03
Copper	1.5E+00	3.9E-01	3.2E-05	4.8E-05	4.0E-02	1.2E-03
Lead	1.1E+00	5.0E-01	4.1E-05	4.5E-05	7.5E-04	6.0E-02
Mercury	1.4E-02	1.0E+00	8.3E-05	1.1E-06	3.0E-04	3.8E-03
Zinc	3.4E+01	1.0E+00	8.3E-05	2.8E-03	3.0E-01	9.4E-03
Hazard Index						2E-01

EXPOSURE ASSUMPTIONS

Daily intake of Fish (FI)	32	(g/day)
Conversion Factor 1 (CF1)	1.0E-03	(kg/g)
Exposure Frequency	66	(day/year)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(FI * CF1 * EF * RAF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-1-8
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Adult Angler
Ingestion of Fish: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+00	9.9E-01	3.3E-05	3.7E-05	N/A	N/A
Ethylbenzene	2.2E+01	1.0E+00	3.3E-05	7.1E-04	N/A	N/A
Isopropylbenzene	1.0E+00	9.9E-01	3.3E-05	3.3E-05	N/A	N/A
o-Xylene	3.1E+01	1.0E+00	3.3E-05	1.0E-03	N/A	N/A
p/m-Xylene	1.2E+02	1.0E+00	3.3E-05	4.0E-03	N/A	N/A
Cadmium	5.2E-02	1.0E+00	3.3E-05	1.7E-06	N/A	N/A
Chromium	2.0E-01	1.0E+00	3.3E-05	6.6E-06	N/A	N/A
Copper	1.5E+00	4.0E-01	1.3E-05	2.0E-05	N/A	N/A
Lead	1.1E+00	5.0E-01	1.7E-05	1.8E-05	N/A	N/A
Mercury	1.4E-02	1.0E+00	3.3E-05	4.6E-07	N/A	N/A
Zinc	3.4E+01	1.0E+00	3.3E-05	1.1E-03	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Daily intake of Fish (FI)	32	(g/day)
Conversion Factor 1 (CF1)	1.0E-03	(kg/g)
Exposure Frequency	66	(day/year)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(FI * CF1 * EF * RAF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table B-2-1
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Sediment Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	8.8E-01	1.1E-01	1.1E-07	9.3E-08	N/A	N/A
2-Butanone	7.0E+00	1.0E-01	9.6E-08	6.7E-07	6.0E-01	1.1E-06
Acetone	7.1E+00	1.0E-01	9.6E-08	6.8E-07	9.0E-01	7.5E-07
Carbon disulfide	1.4E+00	1.1E-01	1.1E-07	1.5E-07	1.0E-01	1.5E-06
Chlorobenzene	1.4E+00	1.0E-01	9.6E-08	1.3E-07	2.0E-02	6.7E-06
Ethyl ether	1.4E+00	1.1E-01	1.1E-07	1.5E-07	2.0E-01	7.3E-07
Ethylbenzene	1.7E+01	2.0E-01	1.9E-07	3.3E-06	1.0E-01	3.3E-05
Fluoranthene	4.1E-01	1.0E-01	9.6E-08	4.0E-08	4.0E-02	9.9E-07
Isopropylbenzene	8.0E-01	1.1E-01	1.1E-07	8.4E-08	1.0E-01	8.4E-07
o-Xylene	2.5E+01	1.2E-01	1.1E-07	2.8E-06	2.0E-01	1.4E-05
p/m-Xylene	9.6E+01	1.2E-01	1.1E-07	1.1E-05	2.0E-01	5.5E-05
Barium	3.0E+01	5.0E-02	4.8E-08	1.4E-06	2.0E-01	7.2E-06
Cadmium	1.2E+00	1.4E-01	1.3E-07	1.6E-07	1.0E-03	1.6E-04
Chromium	1.9E+01	9.0E-02	8.6E-08	1.6E-06	3.0E-03	5.3E-04
Copper	1.8E+01	3.0E-02	2.9E-08	5.0E-07	4.0E-02	1.3E-05
Lead	2.7E+01	6.0E-03	5.7E-09	1.6E-07	7.5E-04	2.1E-04
Mercury	1.6E-01	5.0E-02	4.8E-08	7.5E-09	3.0E-04	2.5E-05
Zinc	1.1E+02	2.0E-02	1.9E-08	2.0E-06	3.0E-01	6.7E-06
Hazard Index						1E-03

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,467	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Adherence Factor (AF)	1	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-2-2
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Sediment Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	8.8E-01	N/A	N/A	N/A	N/A	N/A
2-Butanone	7.0E+00	N/A	N/A	N/A	N/A	N/A
Acetone	7.1E+00	N/A	N/A	N/A	N/A	N/A
Carbon disulfide	1.4E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
Ethyl ether	1.4E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	1.7E+01	N/A	N/A	N/A	N/A	N/A
Fluoranthene	4.1E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	8.0E-01	N/A	N/A	N/A	N/A	N/A
o-Xylene	2.5E+01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	9.6E+01	N/A	N/A	N/A	N/A	N/A
Barium	3.0E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	1.2E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.9E+01	N/A	N/A	N/A	N/A	N/A
Copper	1.8E+01	N/A	N/A	N/A	N/A	N/A
Lead	2.7E+01	N/A	N/A	N/A	N/A	N/A
Mercury	1.6E-01	N/A	N/A	N/A	N/A	N/A
Zinc	1.1E+02	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)		5,467	cm^2
Conversion Factor 1 (CF1)		1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)		0.042	(day/hour)
Adherence Factor (AF)		1	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific		(unitless)
Exposure Time (ET)		1	(hours/day)
Exposure Frequency (EF)		66	(days/year)
Exposure Duration (ED)		11	(years)
Body Weight (BW)		43	(kg)
Averaging Time (AT)		27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK
Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table B-2-3
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Incidental Surface Water Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (L/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
p/m-Xylene	8.0E-04	1.0E+00	8.8E-06	7.0E-09	2.0E-01	3.5E-08
Hazard Index						4E-08

EXPOSURE ASSUMPTIONS

Volume of Surface Water Ingested (VI	50	(ml/day)
Conversion Factor 1 (CF1)	0.042	(day/hour)
Conversion Factor 2 (CF2)	0.001	(L/mL)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-2-4
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Incidental Surface Water Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (L/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
p/m-Xylene	8.0E-04	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Volume of Surface Water Ingested (VI	50	(ml/day)
Conversion Factor 1 (CF1)	0.042	(day/hour)
Conversion Factor 2 (CF2)	0.001	(L/mL)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	1	(hours/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table B-2-5
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Surface Water Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
p/m-Xylene	8.0E-04	1.2E-01	2.8E+00	2.1E-07	2.0E-01	1.0E-06
Hazard Index						1E-06

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)		5,467	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific		(unitless)
Event Frequency (EV)		1	(event/day)
Exposure Frequency (EF)		66	(days/year)
Exposure Duration (ED)		11	(years)
Body Weight (BW)		43	(kg)
Averaging Time (AT)		4,015	(days)

EQUATION FOR DERMAL ABSORPTION DOSE (DAD)

DAD = (DA_{event} * Exposure Factor)

Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = DAD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-2-6
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Surface Water Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/L (ppm))	RAF (unitless)	Exposure Factor (cm^2-event/kg-day)	DAD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
p/m-Xylene	8.0E-04	N/A	N/A	N/A	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5,467	(cm^2)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Event Frequency (EV)	1	(event/day)
Exposure Frequency (EF)	66	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

DAD = (DA_{event} * Exposure Factor)
Exposure Factor = [(SA * RAF * EV * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = DAD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Tables B-2-6.Supplement A
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth
Calculation of DAevent
Reichhold, Inc., Andover, Massachusetts

Chemical of Potential Concern	Surface Water Concentration (CW) (ug/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
p/m-Xylene	8.00E-01	5.2E-02	2.1E-01	4.1E-01	9.9E-01	1.0E+00	1.0	7.6E-08	3

Inorganics: DAevent (mg/cm2-event) =

DA_{event} = Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (Eq 1)

Organics: DAevent (mg/cm2-event) =

DA_{event} = t_{event}<t*: DA_{event} (mg/cm^2-event) =
2 x FA x Kp x Cw x (sqrt((6 x τ x t_{event}) / (3.1415))) x CF1 x CF2 (Eq 2)

t_{event}>t*: DA_{event} (mg/cm^2-event) =
FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x ((1 + 3B + 3B^2)/(1+B)^2)) xCF1 x CF2 (Eq 3)

Note:
Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final).* EPA/540/R/99/005.

Table B-2-7
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth Angler
Ingestion of Fish: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+00	9.9E-01	1.3E-04	1.5E-04	N/A	N/A
Ethylbenzene	2.2E+01	1.0E+00	1.3E-04	2.9E-03	1.0E-01	2.9E-02
Isopropylbenzene	1.0E+00	9.9E-01	1.3E-04	1.3E-04	1.0E-01	1.3E-03
o-Xylene	3.1E+01	1.0E+00	1.3E-04	4.2E-03	2.0E-01	2.1E-02
p/m-Xylene	1.2E+02	1.0E+00	1.3E-04	1.6E-02	2.0E-01	8.2E-02
Cadmium	5.2E-02	1.0E+00	1.3E-04	7.1E-06	1.0E-03	7.1E-03
Chromium	2.0E-01	1.0E+00	1.3E-04	2.7E-05	3.0E-03	8.9E-03
Copper	1.5E+00	3.9E-01	5.2E-05	7.8E-05	4.0E-02	2.0E-03
Lead	1.1E+00	5.0E-01	6.7E-05	7.3E-05	7.5E-04	9.7E-02
Mercury	1.4E-02	1.0E+00	1.3E-04	1.9E-06	3.0E-04	6.2E-03
Zinc	3.4E+01	1.0E+00	1.3E-04	4.6E-03	3.0E-01	1.5E-02
Hazard Index						3E-01

EXPOSURE ASSUMPTIONS

Daily intake of Fish (FI)	32	(g/day)
Conversion Factor 1 (CF1)	1.0E-03	(kg/g)
Exposure Frequency	66	(day/year)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(FI * CF1 * EF * RAF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table B-2-8
Current/Future Land Use Scenario (Former Manufacturing Area) - River Recreational Youth Angler
Ingestion of Fish: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Concentration (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+00	9.9E-01	2.0E-05	2.2E-05	N/A	N/A
Ethylbenzene	2.2E+01	1.0E+00	2.0E-05	4.3E-04	N/A	N/A
Isopropylbenzene	1.0E+00	9.9E-01	2.0E-05	2.0E-05	N/A	N/A
o-Xylene	3.1E+01	1.0E+00	2.0E-05	6.2E-04	N/A	N/A
p/m-Xylene	1.2E+02	1.0E+00	2.0E-05	2.4E-03	N/A	N/A
Cadmium	5.2E-02	1.0E+00	2.0E-05	1.0E-06	N/A	N/A
Chromium	2.0E-01	1.0E+00	2.0E-05	3.9E-06	N/A	N/A
Copper	1.5E+00	4.0E-01	7.9E-06	1.2E-05	N/A	N/A
Lead	1.1E+00	5.0E-01	9.9E-06	1.1E-05	N/A	N/A
Mercury	1.4E-02	1.0E+00	2.0E-05	2.7E-07	N/A	N/A
Zinc	3.4E+01	1.0E+00	2.0E-05	6.7E-04	N/A	N/A
Cancer Risk						N/A

EXPOSURE ASSUMPTIONS

Daily intake of Fish (FI)	32	(g/day)
Conversion Factor 1 (CF1)	1.0E-03	(kg/g)
Exposure Frequency	66	(day/year)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(FI * CF1 * EF * RAF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

APPENDIX C

HHRAA EXPOSURE ESTIMATES SUPPLEMENT TABLES

Table C-1
Calculation of Receptor Body Weight
Reichhold, Inc., Andover, Massachusetts

Age	50th Percentile Age-specific Body Weight (kg)	
	Female	Male
7<8	23.5	24.4
8<9	27.3	27
9<10	29.6	29.7
10<11	34.3	34.5
11<12	40.0	36.4
12<13	45.2	42.1
13<14	48.6	47.7
14<15	52.8	55.5
15<16	53.9	60.2
16<17	55.3	63.6
17<18	58.3	65.7
Average (7 to 18 years of age)	42.6	44.3
Recreational Youth (7 to 18 years of age) [1]		43.5

Note:
Values were obtained from Table B-1 of Appendix B (MADEP, 1995).
[1] Average of male and female

Table C-2
Calculation of Receptor Exposed Skin Surface Area
Reichhold, Inc., Andover, Massachusetts

	Median (50th Percentile) Age-Specific Surface Area (cm^2)							
Age	**Female**				**Male**			
	Head	Hands	Forearms	Lower legs	Head	Hands	Forearms	Lower legs
7<8	1310.0	431.0	600.6	994.0	1226.2	439.9	613.1	1014.6
8<9	1310.0	470.0	655.0	1084.0	1310.0	470.0	655.0	1084.0
9<10	1272.0	561.8	651.9	1228.4	1284.0	567.1	658.1	1228.4
10<11	1404.0	620.1	719.6	1354.6	1416.0	625.4	725.7	1354.6
11<12	1560.0	689.0	799.5	1412.0	1476.0	651.9	756.5	1412.0
12<13	1223.6	756.0	959.0	1634.8	1171.2	723.6	917.9	1634.8
13<14	1475.6	754.8	895.4	1881.6	1465.6	749.7	889.4	1881.6
14<15	1545.4	790.5	937.8	2060.8	1605.2	821.1	974.1	2060.8
15<16	1249.7	800.7	949.9	2176.0	1353.2	867.0	1028.5	2176.0
16<17	1273.6	912.0	1048.0	2365.4	1401.0	1003.2	1152.8	2365.4
17<18	1297.5	831.3	1426.3	2217.6	1432.8	918.0	1575.0	2217.6
Average (ages 7 to 18)	1356.5	692.5	876.6	1673.6	1376.5	712.4	904.2	1675.4
Average Total (ages 7 to 18)				4599.2				4668.5
Recreational Youth (7 to 18 years of age)							4633.9	(cm^2)

Note:
Values were obtained from Table B-2 of Appendix B (MADEP, 1995).

Table C-3
Calculation of Volatilization Factors
Reichhold, Inc., Andover, Massachusetts

Chemical	Diffusivity in Air (D_i) (cm^2/s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D_w) (cm^2/s)	Soil Organic Carbon Partition Coeff. (K_{oc}) (cm^3/g)	Solubility in Water (S) (mg/L)	Soil Water Partition Coeff. ($K_d = K_{oc} \times F_{oc}$) ($g/cm^3$)	Apparent Diffusivity (D_A) (cm^2/s)	Volatilization Factor (VF) (m^3/kg)	Reference
1,2,4-Trimethylbenzene	6.1E-02	2.5E-01	7.9E-06	1.4E+03	5.7E+01	8.1E+00	9.8E-05	1.2E+04	J&E Model
1,2-Dichlorobenzene	6.9E-02	7.8E-02	7.9E-06	6.2E+02	1.6E+02	3.7E+00	7.5E-05	1.4E+04	SSL
1,3,5-Trimethylbenzene	6.0E-02	2.4E-01	8.7E-06	1.4E+03	2.0E+00	8.1E+00	9.3E-05	1.2E+04	J&E Model
1,4-Dichlorobenzene	6.9E-02	1.0E-01	7.9E-06	6.2E+02	7.4E+01	3.7E+00	9.6E-05	1.2E+04	SSL
2-Butanone	8.1E-02	2.3E-03	9.8E-06	2.3E+00	2.2E+05	1.4E-02	8.7E-05	1.3E+04	J&E Model
4-Methyl-2-pentanone	7.5E-02	5.6E-03	7.8E-06	9.1E+00	1.9E+04	5.4E-02	1.5E-04	9.9E+03	J&E Model
Acetone	1.2E-01	1.6E-03	1.1E-05	5.8E-01	1.0E+06	3.5E-03	1.0E-04	1.2E+04	SSL
Benzene	8.8E-02	2.3E-01	9.8E-06	5.9E+01	1.8E+03	3.5E-01	2.2E-03	2.6E+03	SSL
Carbon disulfide	1.0E-01	1.2E+00	1.0E-05	4.6E+01	1.2E+03	2.7E-01	1.1E-02	1.1E+03	SSL
Chlorobenzene	7.3E-02	1.5E-01	8.7E-06	2.2E+02	4.7E+02	1.3E+00	4.1E-04	5.9E+03	SSL
Ethylbenzene	7.5E-02	3.2E-01	7.8E-06	3.6E+02	1.7E+02	2.2E+00	5.5E-04	5.1E+03	SSL
Isopropylbenzene	6.5E-02	4.7E+01	7.1E-06	4.9E+02	6.1E+01	2.9E+00	1.4E-02	1.0E+03	J&E Model
n-Butylbenzene	5.7E-02	5.4E-01	8.1E-06	1.1E+03	2.0E+00	6.7E+00	2.4E-04	7.7E+03	J&E Model
n-Propylbenzene	6.0E-02	4.4E-01	7.8E-06	5.6E+02	6.0E+01	3.4E+00	3.9E-04	6.0E+03	J&E Model
Naphthalene	5.9E-02	2.0E-02	7.5E-06	2.0E+03	3.1E+01	1.2E+01	5.1E-06	5.2E+04	SSL
Methyl tert butyl ether	1.0E-01	2.6E-02	1.1E-05	7.3E+00	5.1E+04	4.4E-02	9.4E-04	3.9E+03	J&E Model
Methylene chloride	1.0E-01	9.0E-02	1.2E-05	1.2E+01	1.3E+04	7.0E-02	2.6E-03	2.3E+03	SSL
o-Xylene	8.7E-02	2.1E-01	1.0E-05	3.6E+02	1.8E+02	2.2E+00	4.3E-04	5.8E+03	SSL
p-Isopropyltoluene[1]	6.5E-02	4.7E+01	7.1E-06	4.9E+02	6.1E+01	2.9E+00	1.4E-02	1.0E+03	surrogate[1]
p/m-Xylene[2]	7.7E-02	3.1E-01	8.4E-06	3.9E+02	1.9E+02	2.3E+00	5.2E-04	5.2E+03	SSL
sec-Butylbenzene	5.7E-02	5.7E-01	8.1E-06	9.7E+02	3.9E+00	5.8E+00	2.9E-04	7.0E+03	J&E Model
Styrene	7.1E-02	1.1E-01	8.0E-06	7.8E+02	3.1E+02	4.7E+00	8.9E-05	1.3E+04	SSL
Toluene	8.7E-02	2.7E-01	8.6E-06	1.8E+02	5.3E+02	1.1E+00	1.0E-03	3.7E+03	SSL
Total Xylenes[2]	7.7E-02	3.1E-01	8.4E-06	3.9E+02	1.9E+02	2.3E+00	5.2E-04	5.2E+03	SSL

Equations:

Volatilization factor (VF) = (m^3/kg)

$$\frac{Q/C_{vol} * (3.14 * D_A * T)^{1/2} * 10^{-4}\ (m^2/cm^2)}{2 * r_b * D_A}$$

Apparent Diffusivity (D_A) = (cm^2/s)

$$\frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}$$

Parameters	**Values**
Q/C_{vol} - Inverse of the geometric mean air concentration to the volatilization flux at the center of a 0.5 acre-square source (g/m^2-s per kg/m^3)	65.36
T - Exposure interval(s)	9.5E+08
r_b - Soil bulk density (g/cm^3)	1.5
Q_a - Air-filled soil porosity (L_{air}/L_{soil}) = n - Q_w	0.28
n - Total soil porosity (L_{pore}/L_{soil}) = 1 - (r_b/r_s)	0.43
Q_w - Water-filled soil porosity (L_{water}/L_{soil})	0.15
r_s - Soil particle density (g/cm^3)	2.65
f_{oc} - fraction organic carbon in soil (g/g)	0.006

Note:

Q/C value for 0.5 acre source area in Zone 8, Hartford, Connecticut, from the Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24 (EPA, 2002).

SSL = Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24 (EPA, 2002). Chemical and physical properties from Exhibit C-1.

J&E Model = Johnson and Ettinger Model (USEPA, 2004). Chemical and physical properties from Johnson and Ettinger Model Vlookup Spreadsheet.

[1] Isopropylbenzene was used as a surrogate.

[2] p-Xylene was used as a surrogate.

Table C-4
Johnson and Ettinger Groundwater Input Parameter Values
Reichhold, Inc., Andover, Massachusetts

Symbol	Parameter	Description	Value	Units	Sources
T_S	Average Soil/Groundwater Temperature		10	°C	MassDEP generic assumption (average shallow groundwater temperature) (MADEP, 2009).
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil.	183	cm	MassDEP generic assumption (6 feet) (MADEP, 2009).
L_{WT}	Depth Below Grade to Water Table		213	cm	MassDEP generic assumption (7 feet) (MADEP, 2009).
h_A	Thickness of Soil Stratum A		213	cm	Thickness of soil stratum A is assumed to be consistent with depth below grade to water table.
h_B	Thickness of Soil Stratum B		NA	cm	Not used.
h_C	Thickness of Soil Stratum C		NA	cm	Not used.
	Soil Stratum Directly above Water Table		A	unitless	Consistent with the deepest stratum with a specified thickness (h_A).
k_v	User-Defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores.	NA	cm^2	Not Used
	Stratum A SCS Soil Type	Used to estimate soil vapor permeability.	S	unitless	MassDEP generic assumption (sand) (MADEP, 2009).
ρ_b^A	Stratum A Soil Dry Bulk Density		1.5	g/cm^3	Default for sand.
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity.	0.430	unitless	Default for sand.
θ_w^A	Stratum A Soil Water-Filled porosity	Used with total porosity to calculate air-filled porosity.	0.06	cm^3/cm^3	Default for sand.
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm^3	Not used.
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity.	NA	unitless	Not used.
θ_w^B	Stratum B Soil Water-Filled porosity	Used with total porosity to calculate air-filled porosity.	NA	cm^3/cm^3	Not used.
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm^3	Not used.
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity.	NA	unitless	Not used.
$\theta_{w\backslash}^C$	Stratum C Soil Water-Filled porosity	Used with total porosity to calculate air-filled porosity.	NA	cm^3/cm^3	Not used.
L_{crack}	Enclosed Space Floor Thickness		15	cm	MassDEP generic assumption (MADEP, 2009).
Δ_P	Soil-Building Pressure Differential		40	$g/cm\text{-}s^2$	MassDEP generic assumption (MADEP, 2009).
L_B	Enclosed Space Floor Length		961	cm	MassDEP generic assumption (MADEP, 2009).
W_B	Enclosed Space Floor Width		961	cm	MassDEP generic assumption (MADEP, 2009).
H_B	Enclosed Space Height		488	cm	MassDEP generic assumption (MADEP, 2009).
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building.	0.1	cm	MassDEP generic assumption (MADEP, 2009).
ER	Indoor Air Exchange Rate	Building ventilation rate, expressed in units of air changes per hour (ACH).	0.45	(1/h)	MassDEP generic assumption (MADEP, 2009).
Q_{soil}	Average vapor flow rate into bldg.		Blank	(L/min)	

Note:
MADEP, 2009 - Numerical Standards Spreadsheets.

Table C-5
Johnson and Ettinger Groundwater Version 3.1 Advanced Model Example and Output Values
Reichhold, Inc., Andover, Massachusetts

CASRN	Chemical	Groundwater Concentration[4] (ug/L)	Diffusivity in air, Da (cm2/s)	Diffusivity in water, Dw (cm2/s)	Henry's law constant at reference temperature, H (atm-m3/mol)	Henry's law constant reference temperature, TR (oC)	Enthalpy of vaporization at the normal boiling point, DHv,b (cal/mol)	Normal boiling point, TB (oK)	Critical temperature, TC (oK)	Organic carbon partition coefficient, Koc (cm3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF (mg/m3)-1	Reference conc., RfC (mg/m3)	Exposure duration, t (sec)	Source-building separation, L_T (cm)
Future Industrial Worker Scenario															
95636	1,2,4-Trimethylbenzene	5.09E+03	6E-02	8E-06	6E-03	3E+01	9E+03	4E+02	6E+02	1E+03	6E+01	0E+00	6E-03	8E+08	3E+01
95501	1,2-Dichlorobenzene	2.00E+01	7E-02	8E-06	2E-03	3E+01	1E+04	5E+02	7E+02	6E+02	2E+02	0E+00	2E-01	8E+08	3E+01
107062	1,2-Dichloroethane	1.80E+00	1E-01	1E-05	1E-03	3E+01	8E+03	4E+02	6E+02	2E+01	9E+03	3E-05	0E+00	8E+08	3E+01
108678	1,3,5-Trimethylbenzene	1.80E+03	6E-02	9E-06	6E-03	3E+01	9E+03	4E+02	6E+02	1E+03	2E+00	0E+00	6E-03	8E+08	3E+01
541731	1,3-Dichlorobenzene	4.60E+00	7E-02	8E-06	3E-03	3E+01	9E+03	4E+02	7E+02	2E+03	1E+02	0E+00	1E-01	8E+08	3E+01
106467	1,4-Dichlorobenzene	8.60E+01	7E-02	8E-06	2E-03	3E+01	9E+03	4E+02	7E+02	6E+02	8E+01	0E+00	8E-01	8E+08	3E+01
108101	4-Methyl-2-pentanone	7.65E+02	8E-02	8E-06	1E-04	3E+01	8E+03	4E+02	6E+02	9E+00	2E+04	0E+00	3E+00	8E+08	3E+01
67641	Acetone	9.00E+00	1E-01	1E-05	4E-05	3E+01	7E+03	3E+02	5E+02	6E-01	1E+06	0E+00	4E-01	8E+08	3E+01
71432	Benzene	1.09E+02	9E-02	1E-05	6E-03	3E+01	7E+03	4E+02	6E+02	6E+01	2E+03	8E-06	3E-02	8E+08	3E+01
108907	Chlorobenzene[5]	3.54E+02	7E-02	9E-06	4E-03	3E+01	8E+03	4E+02	6E+02	2E+02	5E+02	0E+00	6E-02	8E+08	3E+01
100414	Ethylbenzene	1.56E+04	8E-02	8E-06	8E-03	3E+01	9E+03	4E+02	6E+02	4E+02	2E+02	0E+00	1E+00	8E+08	3E+01
98828	Isopropylbenzene	9.50E+01	7E-02	7E-06	1E-02	3E+01	1E+04	4E+02	6E+02	5E+02	6E+01	0E+00	4E-01	8E+08	3E+01
1634044	Methyl tert butyl ether	1.00E+01	1E-01	1E-05	6E-04	3E+01	7E+03	3E+02	5E+02	7E+00	5E+04	0E+00	3E+00	8E+08	3E+01
91203	Naphthalene	2.63E+02	6E-02	8E-06	5E-04	3E+01	1E+04	5E+02	7E+02	2E+03	3E+01	0E+00	3E-03	8E+08	3E+01
104518	n-Butylbenzene	5.80E+01	6E-02	8E-06	1E-02	3E+01	9E+03	5E+02	7E+02	1E+03	2E+00	0E+00	1E-01	8E+08	3E+01
103651	n-Propylbenzene	1.09E+02	6E-02	8E-06	1E-02	3E+01	9E+03	4E+02	6E+02	6E+02	6E+01	0E+00	1E-01	8E+08	3E+01
95476	o-Xylene	1.90E+03	9E-02	1E-05	5E-03	3E+01	9E+03	4E+02	6E+02	4E+02	2E+02	0E+00	1E-01	8E+08	3E+01
1330207	p/m-Xylene[1]	6.90E+03	8E-02	8E-06	8E-03	3E+01	9E+03	4E+02	6E+02	4E+02	2E+02	0E+00	1E-01	8E+08	3E+01
99876	p-Isopropyltoluene[2]	1.56E+02	7E-02	7E-06	1E-02	3E+01	1E+04	4E+02	6E+02	5E+02	6E+01	0E+00	4E-01	8E+08	3E+01
135988	sec-Butylbenzene	3.40E+00	6E-02	8E-06	1E-02	3E+01	9E+04	4E+02	7E+02	1E+03	4E+00	0E+00	1E-01	8E+08	3E+01
100425	Styrene[5]	2.09E+01	7E-02	8E-06	3E-03	3E+01	9E+03	4E+02	6E+02	8E+02	3E+02	0E+00	1E+00	8E+08	3E+01
98066	tert-Butylbenzene	9.00E-01	6E-02	8E-06	1E-02	3E+01	9E+03	4E+02	1E+03	8E+02	3E+01	0E+00	1E-01	8E+08	3E+01
994058	Tertiary-Amyl Methyl Ether[3]	5.60E+00	1E-01	1E-05	6E-04	3E+01	7E+03	3E+02	5E+02	7E+00	5E+04	0E+00	3E+00	8E+08	3E+01
108883	Toluene	6.30E+01	9E-02	9E-06	7E-03	3E+01	8E+03	4E+02	6E+02	2E+02	5E+02	0E+00	4E-01	8E+08	3E+01
Current Industrial Worker Scenario															
1634044	Methyl tert butyl ether	2.70E+00	1E-01	1E-05	6E-04	3E+01	7E+03	3E+02	5E+02	7E+00	5E+04	0E+00	3E+00	8E+08	3E+01

CASRN	Chemical	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)
Future Industrial Worker Scenario																	
95636	1,2,4-Trimethylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
95501	1,2-Dichlorobenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
107062	1,2-Dichloroethane	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
108678	1,3,5-Trimethylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
541731	1,3-Dichlorobenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
106467	1,4-Dichlorobenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
108101	4-Methyl-2-pentanone	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
67641	Acetone	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
71432	Benzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
108907	Chlorobenzene[5]	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
100414	Ethylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
98828	Isopropylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
1634044	Methyl tert butyl ether	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
91203	Naphthalene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
104518	n-Butylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
103651	n-Propylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
95476	o-Xylene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
1330207	p/m-Xylene[1]	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
99876	p-Isopropyltoluene[2]	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
135988	sec-Butylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
100425	Styrene[5]	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
98066	tert-Butylbenzene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
994058	Tertiary-Amyl Methyl Ether[3]	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
108883	Toluene	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02
Current Industrial Worker Scenario																	
1634044	Methyl tert butyl ether	4E-01	ERROR	ERROR	2E-02	1E-07	1E+00	1E-07	2E+01	4E-01	2E-01	3E-01	4E+03	6E+04	2E+06	2E-04	2E+02

CASRN	Chemical	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	A effective diffusion coefficient, D^{eff}_A (cm^2/s)	B effective diffusion coefficient, D^{eff}_B (cm^2/s)	C effective diffusion coefficient, D^{eff}_C (cm^2/s)	zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
Future Industrial Worker Scenario												
95636	1,2,4-Trimethylbenzene	1E+04	2E-03	9E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
95501	1,2-Dichlorobenzene	1E+04	7E-04	3E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
107062	1,2-Dichloroethane	9E+03	5E-04	2E-02	2E-04	2E-02	0E+00	0E+00	2E-03	3E-03	3E+01	2E+02
108678	1,3,5-Trimethylbenzene	1E+04	2E-03	9E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
541731	1,3-Dichlorobenzene	1E+04	1E-03	5E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
106467	1,4-Dichlorobenzene	1E+04	9E-04	4E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
108101	4-Methyl-2-pentanone	1E+04	6E-05	2E-03	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
67641	Acetone	8E+03	2E-05	8E-04	2E-04	2E-02	0E+00	0E+00	3E-03	5E-03	3E+01	2E+02
71432	Benzene	8E+03	3E-03	1E-01	2E-04	2E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
108907	Chlorobenzene[5]	1E+04	3E-03	1E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
100414	Ethylbenzene	1E+04	3E-03	1E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
98828	Isopropylbenzene	1E+04	5E-03	2E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
1634044	Methyl tert butyl ether	7E+03	3E-04	1E-02	2E-04	2E-02	0E+00	0E+00	2E-03	3E-03	3E+01	2E+02
91203	Naphthalene	1E+04	2E-04	7E-03	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
104518	n-Butylbenzene	1E+04	5E-03	2E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
103651	n-Propylbenzene	1E+04	4E-03	2E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
95476	o-Xylene	1E+04	2E-03	9E-02	2E-04	2E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
1330207	p/m-Xylene[1]	1E+04	3E-03	1E-01	2E-04	2E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
99876	p-Isopropyltoluene[2]	1E+04	5E-03	2E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
135988	sec-Butylbenzene	1E+05	9E-07	4E-05	2E-04	1E-02	0E+00	0E+00	1E-02	1E-02	3E+01	2E+02
100425	Styrene[5]	1E+04	1E-03	5E-02	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
98066	tert-Butylbenzene	9E+03	5E-03	2E-01	2E-04	1E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
994058	Tertiary-Amyl Methyl Ether[3]	7E+03	3E-04	1E-02	2E-04	2E-02	0E+00	0E+00	2E-03	3E-03	3E+01	2E+02
108883	Toluene	9E+03	3E-03	1E-01	2E-04	2E-02	0E+00	0E+00	1E-03	2E-03	3E+01	2E+02
Current Industrial Worker Scenario												
1634044	Methyl tert butyl ether	7E+03	3E-04	1E-02	2E-04	2E-02	0E+00	0E+00	2E-03	3E-03	3E+01	2E+02

CASRN	Chemical	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	source indoor attenuation coefficient, α (unitless)	**Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)**
Future Industrial Worker Scenario									
95636	1,2,4-Trimethylbenzene	4.732E+05	1E-01	7E+01	1E-02	4E+02	1E+62	7E-04	**321.928998**
95501	1,2-Dichlorobenzene	5.738E+02	1E-01	7E+01	1E-02	4E+02	3E+54	7E-04	**0.41248071**
107062	1,2-Dichloroethane	3.531E+01	1E-01	7E+01	2E-02	4E+02	2E+36	8E-04	**0.02917116**
108678	1,3,5-Trimethylbenzene	1.600E+05	1E-01	7E+01	1E-02	4E+02	3E+62	7E-04	**108.580576**
541731	1,3-Dichlorobenzene	2.254E+02	1E-01	7E+01	1E-02	4E+02	2E+54	7E-04	**0.16191861**
106467	1,4-Dichlorobenzene	3.242E+03	1E-01	7E+01	1E-02	4E+02	3E+54	7E-04	**2.3284568**
108101	4-Methyl-2-pentanone	1.876E+03	1E-01	7E+01	1E-02	4E+02	1E+50	8E-04	**1.44696037**
67641	Acetone	7.626E+00	1E-01	7E+01	2E-02	4E+02	2E+30	9E-04	**0.0070405**
71432	Benzene	1.256E+04	1E-01	7E+01	2E-02	4E+02	6E+42	8E-04	**9.8175212**
108907	Chlorobenzene[5]	2.343E+04	1E-01	7E+01	1E-02	4E+02	4E+51	7E-04	**17.1640449**
100414	Ethylbenzene	2.128E+06	1E-01	7E+01	1E-02	4E+02	1E+50	7E-04	**1572.92428**
98828	Isopropylbenzene	1.927E+04	1E-01	7E+01	1E-02	4E+02	8E+57	7E-04	**13.4784247**
1634044	Methyl tert butyl ether	1.398E+02	1E-01	7E+01	2E-02	4E+02	6E+36	8E-04	**0.11519448**
91203	Naphthalene	1.719E+03	1E-01	7E+01	1E-02	4E+02	6E+63	7E-04	**1.18276431**
104518	n-Butylbenzene	1.136E+04	1E-01	7E+01	1E-02	4E+02	1E+66	7E-04	**7.52335105**
103651	n-Propylbenzene	1.809E+04	1E-01	7E+01	1E-02	4E+02	4E+62	7E-04	**12.2557776**
95476	o-Xylene	1.670E+05	1E-01	7E+01	2E-02	4E+02	2E+43	8E-04	**130.047061**
1330207	p/m-Xylene[1]	9.076E+05	1E-01	7E+01	2E-02	4E+02	9E+48	7E-04	**676.865183**
99876	p-Isopropyltoluene[2]	3.165E+04	1E-01	7E+01	1E-02	4E+02	8E+57	7E-04	**22.1329922**
135988	sec-Butylbenzene	1.289E-01	1E-01	7E+01	1E-02	4E+02	3E+65	1E-03	**0.00013678**
100425	Styrene[5]	9.700E+02	1E-01	7E+01	1E-02	4E+02	1E+53	7E-04	**0.70372661**
98066	tert-Butylbenzene	1.968E+02	1E-01	7E+01	1E-02	4E+02	4E+66	7E-04	**0.12983215**
994058	Tertiary-Amyl Methyl Ether[3]	7.826E+01	1E-01	7E+01	2E-02	4E+02	6E+36	8E-04	**0.06450891**
108883	Toluene	7.921E+03	1E-01	7E+01	2E-02	4E+02	2E+43	8E-04	**6.16554811**
Current Industrial Worker Scenario									
1634044	Methyl tert butyl ether	4E+01	1E-01	7E+01	2E-02	4E+02	6E+36	8E-04	**0.03110251**

Model Input:

Average soil/ groundwater temperature, TS (oC)	below grade to bottom of enclosed space floor, LF (cm)	Depth below grade to water table, LWT (cm)	Thickness of soil stratum A, hA (cm)	Thickness of soil stratum B, (Enter value or 0) hB (cm)	Thickness of soil stratum C, (Enter value or 0) hC (cm)	Soil stratum directly above water table, (Enter A, B, or C)	SCS soil type directly above water table	stratum A SCS soil type used to estima OR soil vapor permeability)	User-defined stratum A soil vapor permeability, kv (cm2)
10	183	213	213	0	0	A	S	S	

Stratum A SCS soil type	Stratum A soil dry bulk density, ρβA (g/cm3)	Stratum A soil total porosity, nA (unitless)	Stratum A soil water-filled porosity, θωA (cm3/cm3)	Stratum B SCS soil type	Stratum B soil dry bulk density, ρβB (g/cm3)	Stratum B soil total porosity, nB (unitless)	Stratum B soil water-filled porosity, θωB (cm3/cm3)	Stratum C SCS soil type	Stratum C soil dry bulk density, ρβX (g/cm3)	Stratum C soil total porosity, nC (unitless)	Stratum C soil water-filled porosity, θωX (cm3/cm3)
S	1.5	0.43	0.06								

Enclosed space floor thickness, Lcrack (cm)	Soil-bldg. pressure differential, ΔΠ (g/cm-s2)	Enclosed space floor length, LB (cm)	Enclosed space floor width, WB (cm)	Enclosed space height, HB (cm)	Floor-wall seam crack width, w (cm)	Indoor air exchange rate, ER (1/h)
10	40	961	961	488	0.1	0.45

Note:
[1] p-xylene was used as a surrogate for p/m-xylene
[2] Isopropylbenzene was used as a surrogate for p-Isopropyltoluene
[3] Methyl tert butyl ether was used as a surrogate for Tertiary-amyl methyl ether
[4] Maximum detected groundwater concentrations were used.
[5] Average detected groundwater concentration at the sample location where the maximum detected concentration was observed
N/A = Not applicable

APPENDIX D

HHRAA DATA RELATED TABLES

Table D-1
Summary of Samples Used in the HHRAA
Reichhold, Inc., Andover, Massachusetts

				Analytes				Exposure Medium/Area								
Matrix	Sample I.D.	Date Collected	Depth (ft)	VOCs	SVOCs	Phenols (4)	Metals	0-2 Ft Soil All Areas	0-6 Ft Soil All Areas	0-6 Ft Soil Utility Corridor	Demolished Concrete All Area	Ground-Water All Areas	Ground-Water Near Buildings	Ground-Water Near Utility Corridor	Surface Water	Sediment
Soil	MFSB7-S	2/10/1997	0.5-3	x	x		x6	x	x							
Soil	MFSB8-S	2/10/1997	0.5-3	x		x	x6	x	x							
Soil	MFSB9-S	2/10/1997	0.5-3	x		x	x6	x	x							
Soil	MFSB10-D	2/10/1997	4-8	x		x	x6		x							
Soil	MFSB2-S	1/30/1997	1-3	x		x	x6	x	x							
Soil	MFSB2-D	1/30/1997	3-5	x		x	x6		x							
Soil	MFSB11-S	2/11/1997	0-3	x		x	x6	x	x							
Soil	MFSB12-S	2/12/1997	0-3	x		x	x6	x	x							
Soil	MFSB13-S	2/11/1997	0-3	x		x	x6	x	x							
Soil	MFSB18-S	2/12/1997	0-3	x	x		x6	x	x							
Soil	MFSB18-D	2/12/1997	4-5	x	x		x6		x							
Soil	MFSB20-S	2/11/1997	0-3	x	x		x7	x	x							
Soil	MFSB15-S	2/10/1997	0-3	x	x		x7	x	x							
Soil	MFA-101	9/11/1998	2.5	x1		x			x							
Soil	MFA-102	9/11/1998	2.5	x1		x			x							
Soil	MFA-103	9/14/1998	4	x1		x			x							
Soil	MFA-104	9/15/1998	4	x1		x			x							
Soil	MFA-105	9/24/1998	4	x1		x			x							
Soil	MFA-106	9/16/1998	5	x1		x			x							
Soil	MFA-107	9/15/1998	5	x1		x			x							
Soil	MFA-108	9/16/1998	5	x1		x			x							
Soil	MFA-109	9/24/1998	4	x1		x			x							
Soil	MFA-KBSW2	9/17/1998	3	x1					x							
Soil	MFA-KBSW3	9/17/1998	3	x1					x							
Soil	MFA-KBSW4B	10/19/1998	3	x1					x							
Soil	MFA-KBBOT2	9/17/1998	4.5	x1					x							
Soil	MFA-STYR1	12/29/1998	4	x2					x							
Soil	MFA-STYR2	12/29/1998	4	x2					x							
Soil	MFA-STYR3	12/29/1998	4	x2					x							
Soil	MFA-STYR4	12/31/1998	4	x2					x							
Soil	MFA-TF1	10/16/1998	3	x1		x			x							
Soil	MFA-TF2	10/16/1998	3	x1		x			x							
Soil	MFA-TF3	10/16/1998	3	x1		x			x							
Soil	MFA-TF4	10/21/1998	3	x1		x			x							
Soil	MFA-110A	10/28/1998	4	x1					x							
Soil	MFA-111B	10/30/1998	4	x1					x							
Soil	MFA-111C	10/30/1998	4	x1					x							
Soil	MFA-112B	10/30/1998	4	x1					x							
Soil	MFA-113	10/28/1998	4	x1					x							
Soil	MFA-CS1	9/11/1998	0-4					x	x							
Soil	MFA-CS2	9/11/1998	0-4	x3				x	x							
Soil	TP-1	3/7/2006	4	x					x							
Soil	TP-3	3/7/2006	4	x					x							
Soil	TP-5	3/7/2006	4	x					x							
Soil	TP-6	3/7/2006	4	x					x							
Soil	TP-9	3/7/2006	4	x					x							
Soil	GP-10	3/28/2006	4-8	x		x			x							
Soil	GP-12	3/29/2006	0-4	x		x		x	x							
Soil	GP-13	3/28/2006	0-3	x		x		x	x	x						
Soil	GP-14	3/29/2006	0-4	x		x		x	x							
Soil	GP-3	3/28/2006	0-4	x		x		x	x							
Soil	GP-4	3/28/2006	0-4	x		x		x	x							
Soil	GP-8	3/29/2006	0-4	x		x		x	x							
Soil	GP-9	3/29/2006	0-4	x		x		x	x							
Soil	UB-1S-0-2	4/24/2007	0-2	x	x	x	x7	x	x							
Soil	UB-1D-6-8	4/24/2007	6-8	x	x	x	x7		x							
Soil	UB-2S-0-2	4/24/2007	0-2	x		x		x	x	x						
Soil	UB-2D-2-6	4/24/2007	2-6	x		x			x	x						
Soil	UB-3S-0-2	4/24/2007	0-2	x		x		x	x	x						
Soil	UB-3D-2-6	4/24/2007	2-6	x		x			x	x						
Soil	UB-4S-0-2	4/24/2007	0-2	x		x		x	x	x						
Soil	UB-4D-2-6	4/24/2007	2-6	x		x			x	x						
Soil	UB-5S-0-2	4/24/2007	0-2	x		x		x	x	x						
Soil	UB-5D-6-10	4/25/2007	6-10	x		x			x	x						
Soil	UB-6S-0-2	4/24/2007	0-2	x	x	x	x7	x	x	x						
Soil	UB-6D-6-10	4/24/2007	6-10	x	x	x	x7		x	x						
Soil	UB-7S-0-2	4/24/2007	0-2	x		x		x	x							
Soil	UB-7D-2-6	4/24/2007	2-6	x		x			x							
Soil	UB-8S-0-2	4/24/2007	0-2	x		x		x	x							
Soil	UB-8D-4-8	4/24/2007	4-8	x		x			x							
Soil	TP-1-US	7/1/2007	3.5-5.5	x	x		x7		x							
Soil	TP-2-US	7/1/2007	6-8	x	x				x							
Soil	TP-3-US	7/1/2007	2-3	x	x		x7		x							
Soil	TP-4-US	7/1/2007	4	x	x		x7		x							
Soil	TP-5-US	7/1/2007	4	x	x		x7		x							
Soil	TP-1-0-2	7/1/2007	0-2	x	x		x7	x	x							
Soil	TP-2-0-2	7/1/2007	0-2	x	x		x7	x	x							
Soil	TP-3-0-2	7/1/2007	0-2	x	x		x7	x	x							
Soil	TP-3A-US	7/1/2007	2	x	x			x	x							
Soil	FMA-HS-1-0-2	6/18/2008	0-2				x9	x	x							
Soil	FMA-HS-1-2-4	6/18/2008	2-4				x9		x							
Soil	FMA-HS-2-0-2	6/18/2008	0-2				x9	x	x							
Soil	FMA-HS-2-2-4	6/18/2008	2-4				x9		x							
Soil	FMA-HS-3-0-2	6/18/2008	0-2				x9	x	x							
Soil	FMA-HS-3-2-4	6/18/2008	2-4				x9		x							

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Summary of Samples Used in the HHRAA
Reichhold, Inc., Andover, Massachusetts

				Analytes				Exposure Medium/Area								
Matrix	Sample I.D.	Date Collected	Depth (ft)	VOCs	SVOCs	Phenols (4)	Metals	0-2 Ft Soil All Areas	0-6 Ft Soil All Areas	0-6 Ft Soil Utility Corridor	Demolished Concrete All Area	Ground-Water All Areas	Ground-Water Near Buildings	Ground-Water Near Utility Corridor	Surface Water	Sediment
Soil	FMA-HS-4-0-2	6/18/2008	0-2				x9	x	x							
Soil	FMA-HS-4-2-4	6/18/2008	2-4				x9		x							
Soil	FMA-HS-5-0-2	6/18/2008	0-2				x9	x	x							
Soil	FMA-HS-5-2-4	6/18/2008	2-4				x9		x							
Soil	FMA-HS-6-0-2	6/20/2008	0-2				x10	x	x							
Soil	FMA-HS-6-2-4	6/20/2008	2-4				x10		x							
Soil	FMA-HS-6-4-6	6/20/2008	4-6				x10		x							
Soil	FMA-HS-7-0-2	6/20/2008	0-2				x10	x	x							
Soil	FMA-HS-7-2-4	6/20/2008	2-4				x10		x							
Soil	FMA-HS-7-4-6	6/20/2008	4-6				x10		x							
Soil	FMA-HS-8-0-2	6/20/2008	0-2				x10	x	x							
Soil	FMA-HS-8-2-4	6/20/2008	2-4				x10		x							
Soil	FMA-HS-8-4-6	6/20/2008	4-6				x10		x							
Concrete	CP-Garage	10/31/2007	-	x	x	x	x				x					
Concrete	CP-Garage-RS	3/4/2008	-	x							x					
Concrete	CP-Stockroom	10/31/2007	-	x	x	x	x				x					
Concrete	CP-SR-RS	3/4/2008	-	x							x					
Concrete	CP-TF-Clean	10/31/2007	-	x	x	x	x				x					
Concrete	CP-TF-Clean-RS	3/4/2008	-	x							x					
Concrete	CP-Pilot	10/31/2007	-	x	x	x	x				x					
Concrete	CP-Pilot	3/4/2008	-	x							x					
Concrete	CP-TF-Stain	10/31/2007	-	x	x	x	x				x					
Concrete	CP-DUP	10/31/2007	-	x	x	x	x				x					
Concrete	CP-TF-Stain-RS	3/4/2008	-	x							x					
Groundwater	CHMW-13 †	07/06/06	-				x5					x				
Groundwater	MW-6S	07/06/06	-	x								x				
Groundwater	CHMW-12 †	07/07/06	-									x				
Groundwater	CHMW-9	07/07/06	-	x								x				
Groundwater	GM-2 †	07/07/06	-				x5					x				
Groundwater	GP-06 †	07/07/06	-									x				
Groundwater	GP-07	07/07/06	-	x								x				
Groundwater	GP-09	07/07/06	-	x			x5					x				
Groundwater	GP-16	07/07/06	-	x								x				
Groundwater	GP-17	07/07/06	-	x								x				
Groundwater	GM-6S †	10/03/06	-									x				
Groundwater	GP-05	10/03/06	-	x								x				
Groundwater	GP-06 †	10/03/06	-									x				
Groundwater	GP-07	10/03/06	-	x								x				
Groundwater	GP-08	10/03/06	-	x								x				
Groundwater	GP-03	10/05/06	-	x								x				
Groundwater	GM-2 †	12/13/06	-			x	x5					x				
Groundwater	GM-6S †	12/13/2006	-			x						x				
Groundwater	CHMW-9	12/13/2006	-	x		x	x5					x				
Groundwater	CHMW-12 †	12/13/2006	-			x						x				
Groundwater	CHMW-13 †	12/13/2006	-			x	x5					x				
Groundwater	GP-1	12/13/2006	-	x		x						x		x		
Groundwater	GP-2	12/13/2006	-	x		x						x				
Groundwater	GP-3	12/13/2006	-	x		x						x				
Groundwater	GP-4	12/13/2006	-	x		x						x				
Groundwater	GP-5	12/13/2006	-	x		x						x				
Groundwater	GP-6 †	12/13/2006	-			x						x				
Groundwater	GP-7	12/13/2006	-	x		x						x				
Groundwater	GP-8	12/13/2006	-	x		x						x				
Groundwater	GP-9	12/13/2006	-	x		x						x				
Groundwater	GP-10 †	12/13/2006	-			x						x				
Groundwater	GP-11 †	12/13/2006	-			x						x				
Groundwater	GP-12	03/29/06	-	x		x						x				
Groundwater	GP-13	12/13/2006	-	x		x						x		x		
Groundwater	GP-14	03/29/06	-	x		x						x				
Groundwater	GP-15	12/13/2006	-	x		x						x				
Groundwater	GP-16	12/13/2006	-	x		x						x				
Groundwater	GP-17	12/13/2006	-	x		x						x				
Groundwater	GP-18	12/13/2006	-	x		x						x				
Groundwater	GP-19	12/13/2006	-	x		x						x				
Groundwater	GP-20	12/13/2006	-	x		x						x				
Groundwater	UB-1	5/2/2007	-	x	x	x	x8					x	x			
Groundwater	UB-2	5/3/2007	-	x		x						x	x	x		
Groundwater	UB-3	5/3/2007	-	x		x						x	x	x		
Groundwater	UB-4	5/3/2007	-	x		x						x	x	x		
Groundwater	UB-5	5/3/2007	-	x	x	x	x8					x		x		
Groundwater	UB-6	5/3/2007	-	x	x	x	x8					x		x		
Groundwater	UB-7	5/3/2007	-	x		x						x	x			
Groundwater	UB-8	5/2/2007	-	x	x	x	x8					x	x			
Groundwater	GM-2 †	05/03/07	-			x						x				
Groundwater	GM-6S †	05/03/07	-			x						x				
Groundwater	GP-03	05/03/07	-	x		x						x				
Groundwater	GP-05	05/03/07	-	x		x						x				
Groundwater	GP-06 †	05/03/07	-			x						x				
Groundwater	GP-07	05/03/07	-	x		x						x				
Groundwater	GP-08	05/03/07	-	x		x						x				
Groundwater	GP-9	05/04/07	-	x		x						x				
Groundwater	GP-11 †	05/03/07	-			x						x				
Groundwater	GP-16	05/04/07	-	x		x						x				
Groundwater	GP-17	05/04/07	-	x		x						x				
Groundwater	CHMW-9	05/03/07	-	x		x						x				
Groundwater	CHMW-12 †	05/03/07	-			x						x				
Groundwater	CHMW-13 †	05/03/07	-			x						x				
Groundwater	GM-2	6/22/2009	-	x								x				
Groundwater	GM-2	10/1/2009	-	x								x				
Groundwater	GM-2	8/23/2010	-	x								x				
Groundwater	GM-2	12/2/2010	-	x								x				
Groundwater	GM-2	6/17/2011	-	x								x				
Groundwater	GM-2	10/19/2011	-	x								x				

Table D-1
Summary of Samples Used in the HHRAA
Reichhold, Inc., Andover, Massachusetts

				Analytes				Exposure Medium/Area								
Matrix	Sample I.D.	Date Collected	Depth (ft)	VOCs	SVOCs	Phenols (4)	Metals	0-2 Ft Soil All Areas	0-6 Ft Soil All Areas	0-6 Ft Soil Utility Corridor	Demolished Concrete All Area	Ground-Water All Areas	Ground-Water Near Buildings	Ground-Water Near Utility Corridor	Surface Water	Sediment
Groundwater	GM-6S	6/22/2009	-	x								x				
Groundwater	GM-6S	10/1/2009	-	x								x				
Groundwater	GM-6S	8/23/2010	-	x								x				
Groundwater	GM-6S	12/2/2010	-	x								x				
Groundwater	GM-6S	7/17/2011	-	x								x				
Groundwater	GM-6S	10/19/2011	-	x								x				
Groundwater	GP-06	6/30/2009	-	x								x				
Groundwater	GP-06	10/1/2009	-	x								x				
Groundwater	GP-06	8/23/2010	-	x								x				
Groundwater	GP-06	12/2/2010	-	x								x				
Groundwater	GP-06	6/17/2011	-	x								x				
Groundwater	GP-06	10/19/2011	-	x								x				
Groundwater	GP-10	6/22/2009	-	x								x				
Groundwater	GP-10	10/1/2009	-	x								x				
Groundwater	GP-10	8/23/2010	-	x								x				
Groundwater	GP-10	12/2/2010	-	x								x				
Groundwater	GP-10	6/17/2011	-	x								x				
Groundwater	GP-10	10/19/2011	-	x								x				
Groundwater	GP-11	6/22/2009	-	x								x				
Groundwater	GP-11	10/1/2009		x								x				
Groundwater	GP-11	8/23/2010		x								x				
Groundwater	GP-11	12/2/2010		x								x				
Groundwater	GP-11	6/17/2011		x								x				
Groundwater	GP-11	10/19/2011		x								x				
Groundwater	CHMW-12	6/22/2009	-	x								x				
Groundwater	CHMW-12	10/1/2009	-	x								x				
Groundwater	CHMW-12	8/23/2010	-	x								x				
Groundwater	CHMW-12	12/2/2010	-	x								x				
Groundwater	CHMW-12	6/17/2011	-	x								x				
Groundwater	CHMW-12	10/19/2011	-	x								x				
Groundwater	CHMW-13	6/22/2009	-	x								x				
Groundwater	CHMW-13	10/1/2009	-	x								x				
Groundwater	CHMW-13	8/23/2010	-	x								x				
Groundwater	CHMW-13	12/2/2010	-	x								x				
Groundwater	CHMW-13	6/17/2011	-	x								x				
Groundwater	CHMW-13	10/19/2011	-	x								x				
Sediment	SED2-CH12	6/6/2007	0-0.5	x	x	x	x7									x
Sediment	SED3-CH13	6/6/2007	0-0.5	x	x	x	x7									x
Surface Water	SW2-CH12	6/7/2007		x		x									x	
Surface Water	SW3-CH13	6/7/2007		x		x									x	

Note:
1 - Reported naphthalene, MTBE, and BTEX only
2 - Reported styrene and ethylbenzene only
3 - Reported BTEX only
4 - Phenolic compounds
5 - Arsenic and manganese
6 - Cadmium, copper, iron, lead, and zinc
7 - RCRA Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) + iron and zinc
8 - Arsenic, barium, iron, and zinc
9 - copper
10 - cadmium and zinc
† Most recent three years worth of data were used for groundwater monitoring seven wells (GM-2, GM-6S, GP-6, GP-10, GP-11, CHMW-12, and CHMW-13) included in the Operation, Management, Monitoring program.

Table D-2
Evaluation of Exposure Point Concentrations - 0-2 Ft Soil
Reichhold, Inc., Andover, Massachusetts

Receptors:
Current Industrial Worker
Future Recreational Adult
Future Recreational Youth
Exposure Medium: Soil (0-2 ft bgs)

	Risk-Based Concentration [1]									
COC	**Carcino-genic**	**Non-Carcin-ogenic**	**Lowest Value (RBC)**	**Percentage of Data Points ≤ RBC**	**EPC (Average Concentration)**	**EPC ≤ RBC**	**Maximum Concentration**	**Max Conc. <RBC**	**10X RBC**	**Max Conc. < 10X RBC**
1,2,4-Trimethylbenzene		2.6E+02	2.6E+02	100	1.1E+01	yes	2.0E+02	yes	2.6E+03	yes
1,3,5-Trimethylbenzene		1.0E+04	1.0E+04	100	4.7E+00	yes	8.1E+01	yes	1.0E+05	yes
Acetone		6.3E+05	6.3E+05	100	9.2E-01	yes	1.0E-01	yes	6.3E+06	yes
Ethylbenzene	2.7E+02	2.1E+04	2.7E+02	100	9.2E-01	yes	1.5E+01	yes	2.7E+03	yes
Isopropylbenzene (cumene)		1.1E+04	1.1E+04	100	1.1E-01	yes	2.3E-01	yes	1.1E+05	yes
n-Butylbenzene[2]		1.4E+03	1.4E+03	100	1.4E+00	yes	2.6E+01	yes	1.4E+04	yes
n-Propylbenzene[3]		1.8E+03	1.8E+03	100	3.8E-01	yes	6.2E+00	yes	1.8E+04	yes
Naphthalene	1.8E+02	6.2E+02	1.8E+02	100	1.1E+00	yes	1.9E+01	yes	1.8E+03	yes
Methyl tert butyl ether	2.2E+03	6.9E+04	2.2E+03	100	1.9E-01	yes	2.0E-01	yes	2.2E+04	yes
Methylene chloride	9.6E+03	3.1E+03	3.1E+03	100	7.1E-01	yes	1.5E-01	yes	3.1E+04	yes
o-Xylene		3.0E+03	3.0E+03	100	1.4E+00	yes	1.2E+01	yes	3.0E+04	yes
p-Isopropyltoluene[4]		1.1E+04	1.1E+04	100	1.1E-01	yes	2.2E-01	yes	1.1E+05	yes
p/m-Xylene		2.5E+03	2.5E+03	100	6.7E+00	yes	7.7E+01	yes	2.5E+04	yes
Total Xylenes		2.7E+03	2.7E+03	100	2.2E-01	yes	7.1E-01	yes	2.7E+04	yes
2,4-Dimethylphenol		1.2E+04	1.2E+04	100	1.9E-01	yes	4.2E-01	yes	1.2E+05	yes
[5]		3.1E+04	3.1E+04	100	2.8E-01	yes	1.3E+00	yes	3.1E+05	yes
Phenol		1.8E+05	1.8E+05	100	5.6E-01	yes	4.5E+00	yes	1.8E+06	yes
bis(2-Ethylhexyl)phthalate	1.2E+03	1.2E+04	1.2E+03	100	2.6E-01	yes	4.2E-01	yes	1.2E+04	yes
Barium		1.9E+05	1.9E+05	100	2.6E+01	yes	7.7E+01	yes	1.9E+06	yes
Cadmium	9.3E+04	8.0E+02	8.0E+02	100	1.1E+00	yes	5.5E+00	yes	8.0E+03	yes
Copper		4.1E+04	4.1E+04	100	2.2E+01	yes	2.5E+02	yes	4.1E+05	yes
Iron		7.2E+05	7.2E+05	100	1.0E+04	yes	3.1E+04	yes	7.2E+06	yes
Silver		5.1E+03	5.1E+03	100	2.9E-01	yes	6.0E-01	yes	5.1E+04	yes
Zinc		3.1E+05	3.1E+05	100	1.3E+02	yes	5.9E+02	yes	3.1E+06	yes

Note:
Units in mg/kg
[1] Based on USEPA Regional Screening Levels (May 2012), using target ILCR of 1x10-5 and HI=1
[2] Chlorobenzene used as a surrogate.
[3] Bromobenzene used as a surrogate.
[4] Isopropylbenzene used as a surrogate.
[5] 2,6-Dimethylphenol used as a surrogate.
EPC - Exposure point concentration
RBC - Risk-based concentration

Table D-3
Evaluation of Exposure Point Concentrations - 0-6 Ft Soil
Reichhold, Inc., Andover, Massachusetts

Receptor Populations:
Future Industrial Worker
Future Construction Worker
Exposure Medium: Soil (0 - 6 ft bgs)

COC	Risk-Based Concentration [1] Carcino-genic	Risk-Based Concentration [1] Non-Carcin-ogenic	Risk-Based Concentration [1] Lowest Value (RBC)	Percentage of Data Points ≤ RBC	EPC (Average Concentration)	EPC ≤ RBC	Maximum Concentration	Max Conc. <RBC	10X RBC	Max Conc. < 10X RBC
1,2,4-Trimethylbenzene		2.6E+02	2.6E+02	87	1.4E+02	yes	2.1E+03	no	2.6E+03	yes
1,2-Dichlorobenzene		9.8E+03	9.8E+03	100	2.3E+00	yes	3.9E+01	yes	9.8E+04	yes
1,3,5-Trimethylbenzene		1.0E+04	1.0E+04	100	4.6E+01	yes	6.3E+02	yes	1.0E+05	yes
1,4-Dichlorobenzene	1.2E+02	2.5E+04	1.2E+02	100	1.3E+00	yes	3.0E-03	yes	1.2E+03	yes
2-Butanone		2.0E+05	2.0E+05	100	1.0E+01	yes	4.5E-02	yes	2.0E+06	yes
4-Methyl-2-pentanone		5.3E+04	5.3E+04	100	8.4E+00	yes	5.2E-02	yes	5.3E+05	yes
Acetone		6.3E+05	6.3E+05	100	8.7E+00	yes	3.7E+01	yes	6.3E+06	yes
Benzene	5.4E+01	4.5E+02	5.4E+01	100	8.9E-01	yes	9.0E-03	yes	5.4E+02	yes
Carbon disulfide		3.7E+03	3.7E+03	100	1.5E+00	yes	2.0E-03	yes	3.7E+04	yes
Chlorobenzene		1.4E+03	1.4E+03	100	1.8E+00	yes	5.4E+01	yes	1.4E+04	yes
Ethylbenzene	2.7E+02	2.1E+04	2.7E+02	99	8.5E+00	yes	1.4E+02	yes	2.7E+03	yes
Isopropylbenzene (cumene)		1.1E+04	1.1E+04	100	1.9E+00	yes	3.6E+01	yes	1.1E+05	yes
n-Butylbenzene [2]		1.4E+03	1.4E+03	100	1.0E+01	yes	1.2E+02	yes	1.4E+04	yes
n-Propylbenzene [3]		1.8E+03	1.8E+03	100	4.1E+00	yes	6.3E+01	yes	1.8E+04	yes
Naphthalene	1.8E+02	6.2E+02	1.8E+02	98	9.5E+00	yes	1.8E+02	no	1.8E+03	yes
Methyl tert butyl ether	2.2E+03	6.9E+04	2.2E+03	100	1.1E+00	yes	2.0E-01	yes	2.2E+04	yes
Methylene chloride	9.6E+03	3.1E+03	3.1E+03	100	5.1E+00	yes	1.5E-01	yes	3.1E+04	yes
o-Xylene		3.0E+03	3.0E+03	100	1.1E+01	yes	1.4E+02	yes	3.0E+04	yes
p-Isopropyltoluene [4]		1.1E+04	1.1E+04	100	1.7E+00	yes	1.0E+01	yes	1.1E+05	yes
p/m-Xylene		2.5E+03	2.5E+03	100	6.2E+01	yes	7.4E+02	yes	2.5E+04	yes
sec-Butylbenzene [5]		1.4E+03	1.4E+03	100	1.2E+00	yes	4.1E+00	yes	1.4E+04	yes
Styrene		3.6E+04	3.6E+04	100	5.6E+00	yes	1.4E+02	yes	3.6E+05	yes
Toluene		4.5E+04	4.5E+04	100	1.9E+00	yes	6.0E+01	yes	4.5E+05	yes
Total Xylenes		2.7E+03	2.7E+03	100	1.2E+02	yes	2.1E+03	yes	2.7E+04	yes
2,4-Dimethylphenol		1.2E+04	1.2E+04	100	4.2E-01	yes	1.3E+00	yes	1.2E+05	yes
Methylphenol [6]		3.1E+04	3.1E+04	100	5.5E-01	yes	2.6E+00	yes	3.1E+05	yes
Phenol		1.8E+05	1.8E+05	100	1.3E+01	yes	5.6E+02	yes	1.8E+06	yes
2-Methylnaphthalene		2.2E+03	2.2E+03	100	1.2E+00	yes	1.2E+01	yes	2.2E+04	yes
bis(2-Ethylhexyl)phthalate	1.2E+03	1.2E+04	1.2E+03	100	2.8E-01	yes	4.2E-01	yes	1.2E+04	yes
Dibenzofuran [7]		1.0E+02	1.0E+02	100	3.0E-01	yes	4.3E-01	yes	1.0E+03	yes
Phenanthrene [8]		1.7E+05	1.7E+05	100	6.1E-01	yes	4.3E+00	yes	1.7E+06	yes
Arsenic	1.6E+01	2.6E+02	1.6E+01	92	7.8E+00	yes	2.2E+01	no	1.6E+02	yes
Barium		1.9E+05	1.9E+05	100	2.2E+01	yes	7.7E+01	yes	1.9E+06	yes
Cadmium	9.3E+04	8.0E+02	8.0E+02	100	4.7E+01	yes	4.4E+01	yes	8.0E+03	yes
Chromium [9]		1.5E+06	1.5E+06	100	1.7E+01	yes	4.2E+01	yes	1.5E+07	yes
Copper		4.1E+04	4.1E+04	100	1.6E+02	yes	2.5E+02	yes	4.1E+05	yes
Iron		7.2E+05	7.2E+05	100	9.5E+03	yes	3.1E+04	yes	7.2E+06	yes
Lead		8.0E+02	8.0E+02	100	2.3E+01	yes	2.3E+02	yes	8.0E+03	yes
Silver		5.1E+03	5.1E+03	100	3.0E-01	yes	6.0E-01	yes	5.1E+04	yes
Zinc		3.1E+05	3.1E+05	100	7.4E+03	yes	6.0E+03	yes	3.1E+06	yes

Note:
Units in mg/kg
[1] Based on USEPA Regional Screening Levels (May 2012), using target ILCR of 1x10-5 and HI=1
[2] Chlorobenzene used as a surrogate.
[3] Bromobenzene used as a
[4] Isopropylbenzene used as a surrogate.
[5] Chlorobenzene used as a surrogate.
[6] 2,6-Dimethylphenol used as a surrogate.
[7] Calculated using the PPRTV and equations/exposure factors in the Screening Levels for Chemical Contaminants User's Guide (Oak Ridge National Laboratory, May 2008)
[8] Anthracene used as a surrogate.
[9] Trivalent chromium used for non-carcinogenic RBC.
EPC - Exposure point concentration
RBC = Risk-based concentration

Table D-4
Evaluation of Exposure Point Concentrations - 0-6 Ft Soil in the Utility Corridor
Reichhold, Inc., Andover, Massachusetts

Receptor Population:
Current/Future Utility Worker
Exposure Medium: 0-6 Ft Soil along Utility Corridor

	Risk-Based Concentration [1]									
COC	**Carcinogenic**	**Noncarcin-ogenic**	**Lowest Value (RBC)**	**Percentage of Data Points ≤ RBC**	**EPC (Average Concentration)**	**EPC ≤ RBC**	**Max Conc.**	**Max Conc. < RBC**	**10X RBC**	**Max Conc.< 10X RBC**
1,2,4-Trimethylbenzene		2.6E+02	2.6E+02	100	2.4E-01	yes	1.8E+00	yes	2.6E+03	yes
1,3,5-Trimethylbenzene		1.0E+04	1.0E+04	100	1.3E-01	yes	5.2E-01	yes	1.0E+05	yes
1,4-Dichlorobenzene	1.2E+02	2.5E+04	1.2E+02	100	1.2E-01	yes	3.0E-03	yes	1.2E+03	yes
2-Butanone		2.0E+05	2.0E+05	100	3.4E-01	yes	4.5E-02	yes	2.0E+06	yes
Acetone		6.3E+05	6.3E+05	100	3.5E-01	yes	2.1E-01	yes	6.3E+06	yes
Carbon disulfide		3.7E+03	3.7E+03	100	1.9E-01	yes	2.0E-03	yes	3.7E+04	yes
Chlorobenzene		1.4E+03	1.4E+03	100	5.8E-02	yes	4.4E-01	yes	1.4E+04	yes
Ethylbenzene	2.7E+02	2.1E+04	2.7E+02	100	1.4E+00	yes	1.5E+01	yes	2.7E+03	yes
n-Propylbenzene [2]		1.8E+03	1.8E+03	100	2.0E-03	yes	2.0E-03	yes	1.8E+04	yes
Naphthalene	1.8E+02	6.2E+02	1.8E+02	100	1.2E-01	yes	4.0E-03	yes	1.8E+03	yes
o-Xylene		3.0E+03	3.0E+03	100	2.1E+00	yes	1.2E+01	yes	3.0E+04	yes
p/m-Xylene		2.5E+03	2.5E+03	100	9.9E+00	yes	6.5E+01	yes	2.5E+04	yes
Total Xylenes		2.7E+03	2.7E+03	100	7.5E+00	yes	7.5E+01	yes	2.7E+04	yes
2,4-Dimethylphenol		1.2E+04	1.2E+04	100	3.1E-01	yes	4.2E-01	yes	1.2E+05	yes
[3]		3.1E+04	3.1E+04	100	1.3E+00	yes	1.3E+00	yes	3.1E+05	yes
Phenol		1.8E+05	1.8E+05	100	7.9E-01	yes	4.5E+00	yes	1.8E+06	yes
Cadmium	9.3E+04	8.0E+02	8.0E+02	100	4.4E+00	yes	8.4E+00	yes	8.0E+03	yes
Zinc		3.1E+05	3.1E+05	100	3.0E+03	yes	6.0E+03	yes	3.1E+06	yes

Note:
Units in mg/kg
[1] Based on USEPA Regional Screening Levels (May 2012), using target ILCR of 1x10-5 and HI=1.
[2] Bromobenzene used as a surrogate.
[3] 2,6-Dimethylphenol used as a surrogate.
EPC - Exposure point concentration
RBC = Risk-based concentration

Table D-5
Evaluation of Exposure Point Concentrations - Demolished Concrete
Reichhold, Inc., Andover, Massachusetts

Receptors:
Future Industrial Worker
Future Utility Worker
Future Construction Worker
Future Recreational Adult
Future Recreational Youth
Exposure Medium: Demolished Concrete

COC	Risk-Based Concentration [1]									
	Carcino-genic	Non-Carcin-ogenic	Lowest Value (RBC)	Percentage of Data Points ≤ RBC	EPC (Average Concentration)	EPC ≤ RBC	Maximum Concentration	Max Conc. <RBC	10X RBC	Max Conc. < 10X RBC
Acetone		6.3E+05	6.3E+05	100	2.8E-02	yes	5.5E-02	yes	6.3E+06	yes
p/m-Xylene		2.5E+03	2.5E+03	100	4.0E-03	yes	4.0E-03	yes	2.5E+04	yes
Phenol		1.8E+05	1.8E+05	100	3.3E+00	yes	6.1E+00	yes	1.8E+06	yes
C19-C36 Aliphatics	N/A	N/A	N/A	100	3.9E+01	N/A	5.1E+01	N/A	N/A	N/A
Barium		1.9E+05	1.9E+05	100	5.8E+01	yes	7.8E+01	yes	1.9E+06	yes
Cadmium	9.3E+04	8.0E+02	8.0E+02	100	1.2E+00	yes	3.5E+00	yes	8.0E+03	yes
Chromium (Total)[2]		1.5E+06	1.5E+06	100	3.5E+01	yes	5.1E+01	yes	1.5E+07	yes
Chromium (III)		1.5E+06	1.5E+06	100	4.3E+01	yes	5.1E+01	yes	1.5E+07	yes
Copper		4.1E+04	4.1E+04	100	2.9E+01	yes	6.1E+01	yes	4.1E+05	yes
Iron		7.2E+05	7.2E+05	100	1.8E+04	yes	2.7E+04	yes	7.2E+06	yes
Zinc		3.1E+05	3.1E+05	100	1.1E+02	yes	2.1E+02	yes	3.1E+06	yes

Note:
Units in mg/kg
[1] Based on USEPA Regional Screening Levels (May 2012), using target ILCR of 1x10-5 and HI=1
[2] Trivalent chromium used for non-carcinogenic RBC.
EPC - Exposure point concentration
RBC - Risk-based concentration

Table D-6
Evaluation of Hot Spots - 0-2 Ft Soil (With Additional Metals Data)
Reichhold, Inc., Andover, Massachusetts

Receptors:
Current Industrial Worker
Future Recreational Adult
Future Recreational Youth
Exposure Medium: Soil (0-2 ft bgs)

COC	EPC (Average Concentration)	10 X EPC	Maximum Detected Concentration	Max Conc. < 10 X EPC	S-1/GW-2 Soil Standard	Maximum < Standard	100 X EPC	Max Conc. < 100 X EPC
1,2,4-Trimethylbenzene	1.1E+01	1.1E+02	2.0E+02	No	NA	--	1.1E+03	Yes
1,3,5-Trimethylbenzene	4.7E+00	4.7E+01	8.1E+01	No	NA	--	4.7E+02	Yes
Acetone	9.2E-01	9.2E+00	1.0E-01	Yes	5.0E+02	Yes	9.2E+01	Yes
Ethylbenzene	9.2E-01	9.2E+00	1.5E+01	No	1.0E+03	Yes	9.2E+01	Yes
Isopropylbenzene (cumene)	1.1E-01	1.1E+00	2.3E-01	Yes	--	--	1.1E+01	Yes
n-Butylbenzene	1.4E+00	1.4E+01	2.6E+01	No	NA	--	1.4E+02	Yes
n-Propylbenzene	3.8E-01	3.8E+00	6.2E+00	No	NA	--	3.8E+01	Yes
Naphthalene	1.1E+00	1.1E+01	1.9E+01	No	4.0E+01	Yes	1.1E+02	Yes
Methyl tert butyl ether	1.9E-01	1.9E+00	2.0E-01	Yes	--	--	1.9E+01	Yes
Methylene chloride	7.1E-01	7.1E+00	1.5E-01	Yes	--	--	7.1E+01	Yes
o-Xylene	1.4E+00	1.4E+01	1.2E+01	Yes	--	--	1.4E+02	Yes
p-Isopropyltoluene	1.1E-01	1.1E+00	2.2E-01	Yes	--	--	1.1E+01	Yes
p/m-Xylene	6.7E+00	6.7E+01	7.7E+01	No	3.0E+02	Yes	6.7E+02	Yes
Total Xylenes	2.2E-01	2.2E+00	7.1E-01	Yes	--	--	2.2E+01	Yes
2,4-Dimethylphenol	1.9E-01	1.9E+00	4.2E-01	Yes	--	--	1.9E+01	Yes
3-Methylphenol/4-Methylphenol	2.8E-01	2.8E+00	1.3E+00	Yes	--	--	2.8E+01	Yes
Phenol	5.6E-01	5.6E+00	4.5E+00	Yes	--	--	5.6E+01	Yes
bis(2-Ethylhexyl)phthalate	2.6E-01	2.6E+00	4.2E-01	Yes	--	--	2.6E+01	Yes
Barium	2.6E+01	2.6E+02	7.7E+01	Yes	--	--	2.6E+03	Yes
Cadmium	1.1E+00	1.1E+01	5.5E+00	Yes	--	--	1.1E+02	Yes
Copper	2.2E+01	2.2E+02	2.5E+02	No	NA	--	2.2E+03	Yes
Iron	1.0E+04	1.0E+05	3.1E+04	Yes	--	--	1.0E+06	Yes
Silver	2.9E-01	2.9E+00	6.0E-01	Yes	--	--	2.9E+01	Yes
Zinc	1.3E+02	1.3E+03	5.9E+02	Yes	--	--	1.3E+04	Yes

Note:
Units in mg/kg
EPC - Exposure point concentration
NA - Not available

Table D-7
Evaluation of Hot Spots - 0-6 Ft Soil (With Additional Metals Data)
Reichhold, Inc., Andover, Massachusetts

Receptor Populations:
Future Industrial Worker
Future Construction Worker
Exposure Medium: Soil (0 - 6 ft bgs)

COC	EPC (Average Concentration)	10 X EPC	Maximum Concentration	Max Conc. < 10 X EPC	S-2/GW-2 Soil Standard	Maximum < Standard	100 X EPC	Max Conc. < 100 X EPC
1,2,4-Trimethylbenzene	1.4E+02	1.4E+03	2.1E+03	No	NA	--	1.4E+04	Yes
1,2-Dichlorobenzene	2.3E+00	2.3E+01	3.9E+01	No	3.0E+01	No	2.3E+02	Yes
1,3,5-Trimethylbenzene	4.6E+01	4.6E+02	6.3E+02	No	NA	--	4.6E+03	Yes
1,4-Dichlorobenzene	1.3E+00	1.3E+01	3.0E-03	Yes	--	--	1.3E+02	Yes
2-Butanone	1.0E+01	1.0E+02	4.5E-02	Yes	--	--	1.0E+03	Yes
4-Methyl-2-pentanone	8.4E+00	8.4E+01	5.2E-02	Yes	--	--	8.4E+02	Yes
Acetone	8.7E+00	8.7E+01	3.7E+01	Yes	--	--	8.7E+02	Yes
Benzene	8.9E-01	8.9E+00	9.0E-03	Yes	--	--	8.9E+01	Yes
Carbon disulfide	1.5E+00	1.5E+01	2.0E-03	Yes	--	--	1.5E+02	Yes
Chlorobenzene	1.8E+00	1.8E+01	5.4E+01	No	3.0E+00	No	1.8E+02	Yes
Ethylbenzene	8.5E+00	8.5E+01	1.4E+02	No	1.0E+03	Yes	8.5E+02	Yes
Isopropylbenzene (cumene)	1.9E+00	1.9E+01	3.6E+01	No	NA	--	1.9E+02	Yes
n-Butylbenzene	1.0E+01	1.0E+02	1.2E+02	No	NA	--	1.0E+03	Yes
n-Propylbenzene	4.1E+00	4.1E+01	6.3E+01	No	NA	--	4.1E+02	Yes
Naphthalene	9.5E+00	9.5E+01	1.8E+02	No	4.0E+01	No	9.5E+02	Yes
Methyl tert butyl ether	1.1E+00	1.1E+01	2.0E-01	Yes	--	--	1.1E+02	Yes
Methylene chloride	5.1E+00	5.1E+01	1.5E-01	Yes	--	--	5.1E+02	Yes
o-Xylene	1.1E+01	1.1E+02	1.4E+02	No	3.0E+02	Yes	1.1E+03	Yes
p-Isopropyltoluene	1.7E+00	1.7E+01	1.0E+01	Yes	--	--	1.7E+02	Yes
p/m-Xylene	6.2E+01	6.2E+02	7.4E+02	No	3.0E+02	No	6.2E+03	Yes
sec-Butylbenzene	1.2E+00	1.2E+01	4.1E+00	Yes	--	--	1.2E+02	Yes
Styrene	5.6E+00	5.6E+01	1.4E+02	No	4.0E+00	No	5.6E+02	Yes
Toluene	1.9E+00	1.9E+01	6.0E+01	No	1.0E+03	Yes	1.9E+02	Yes
Total Xylenes	1.2E+02	1.2E+03	2.1E+03	No	3.0E+02	No	1.2E+04	Yes
2,4-Dimethylphenol	4.2E-01	4.2E+00	1.3E+00	Yes	--	--	4.2E+01	Yes
3-Methylphenol/4-Methylphenol	5.5E-01	5.5E+00	2.6E+00	Yes	--	--	5.5E+01	Yes
Phenol	1.3E+01	1.3E+02	5.6E+02	No	5.0E+01	No	1.3E+03	Yes
2-Methylnaphthalene	1.2E+00	1.2E+01	1.2E+01	Yes	--	--	1.2E+02	Yes
bis(2-Ethylhexyl)phthalate	2.8E-01	2.8E+00	4.2E-01	Yes	--	--	2.8E+01	Yes
Dibenzofuran	3.0E-01	3.0E+00	4.3E-01	Yes	--	--	3.0E+01	Yes
Phenanthrene	6.1E-01	6.1E+00	4.3E+00	Yes	--	--	6.1E+01	Yes
Arsenic	7.8E+00	7.8E+01	2.2E+01	Yes	--	--	7.8E+02	Yes
Barium	2.2E+01	2.2E+02	7.7E+01	Yes	--	--	2.2E+03	Yes
Cadmium	4.7E+00	4.7E+01	4.4E+01	Yes	--	--	4.7E+02	Yes
Chromium	1.7E+01	1.7E+02	4.2E+01	Yes	--	--	1.7E+03	Yes
Copper	1.6E+01	1.6E+02	2.5E+02	No	NA	--	1.6E+03	Yes
Iron	9.5E+03	9.5E+04	3.1E+04	Yes	--	--	9.5E+05	Yes
Lead	2.3E+01	2.3E+02	2.3E+02	Yes	--	--	2.3E+03	Yes
Silver	3.0E-01	3.0E+00	6.0E-01	Yes	--	--	3.0E+01	Yes
Zinc	7.4E+02	7.4E+03	6.0E+03	Yes	--	--	7.4E+04	Yes

Note:
Units in mg/kg
EPC - Exposure point concentration
NA - Not available

Table D-8
Evaluation of Hot Spots - 0-6 Ft Soil in the Utility Corridor
Reichhold, Inc., Andover, Massachusetts

Receptor Population:
Exposure Medium: 0-6 Ft Soil along Utility Corridor

COC	EPC (Average Concentration)	10 X EPC	Max Concentration	Max Conc. < 10 X EPC	S-2/GW-2 Soil Standard	Maximum < Standard	100 X EPC	Max Conc. < 100 X EPC
1,2,4-Trimethylbenzene	2.4E-01	2.4E+00	1.8E+00	Yes	--	--	2.4E+01	Yes
1,3,5-Trimethylbenzene	1.3E-01	1.3E+00	5.2E-01	Yes	--	--	1.3E+01	Yes
1,4-Dichlorobenzene	1.2E-01	1.2E+00	3.0E-03	Yes	--	--	1.2E+01	Yes
2-Butanone	3.4E-01	3.4E+00	4.5E-02	Yes	--	--	3.4E+01	Yes
Acetone	3.5E-01	3.5E+00	2.1E-01	Yes	--	--	3.5E+01	Yes
Carbon disulfide	1.9E-01	1.9E+00	2.0E-03	Yes	--	--	1.9E+01	Yes
Chlorobenzene	5.8E-02	5.8E-01	4.4E-01	Yes	--	--	5.8E+00	Yes
Ethylbenzene	1.4E+00	1.4E+01	1.5E+01	No	1.0E+03	Yes	1.4E+02	Yes
n-Propylbenzene[2]	2.0E-03	2.0E-02	2.0E-03	Yes	--	--	2.0E-01	Yes
Naphthalene	1.2E-01	1.2E+00	4.0E-03	Yes	--	--	1.2E+01	Yes
o-Xylene	2.1E+00	2.1E+01	1.2E+01	Yes	--	--	2.1E+02	Yes
p/m-Xylene	9.9E+00	9.9E+01	6.5E+01	Yes	--	--	9.9E+02	Yes
Total Xylenes	7.5E+00	7.5E+01	7.5E+01	Yes	--	--	7.5E+02	Yes
2,4-Dimethylphenol	3.1E-01	3.1E+00	4.2E-01	Yes	--	--	3.1E+01	Yes
3-Methylphenol/4-Methylphenol[3]	1.3E+00	1.3E+01	1.3E+00	Yes	--	--	1.3E+02	Yes
Phenol	7.9E-01	7.9E+00	4.5E+00	Yes	--	--	7.9E+01	Yes
Cadmium	4.4E+00	4.4E+01	8.4E+00	Yes	--	--	4.4E+02	Yes
Zinc	3.0E+03	3.0E+04	6.0E+03	Yes	--	--	3.0E+05	Yes

Note:
Units in mg/kg
EPC - Exposure point concentration
NA - Not available

Attachment C - Cumulative Human Health Risk Assessment Calculations

Table C-1-1
Subchronic Toxicity Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Subchronic Oral RfD (mg/kg-day)	Source for Oral RfD[1]	Subchronic Inhalation Reference Concentration (mg/m^3)	Source for Inhalation Reference Concentration[1]
2-Methylphenol	95-48-7	5.00E-01	13	N/A	N/A

Note:
[13] U.S. EPA Health Effects Assessment Summary Tables (HEAST), Annual FY-1997.
N/A - Not Available
RfD - Reference Dose

Table C-1-2
Chronic Toxicity Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Chronic Oral RfD (mg/kg-day)	Source for Oral RfD[1]	Chronic Inhalation Reference Concentration (mg/m^3)	Source for Inhalation Reference Concentration[1]
2-Methylphenol	95-48-7	5.00E-02	†	N/A	N/A
Chloromethane	74-87-3	N/A	N/A	9.00E-02	†
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	8.00E-05	†	N/A	N/A
Trichlorofluoromethane	75-69-4	3.00E-01	†	7.00E-01	13

Note:
[13] This value was developed by MA DEP ORS Air/Water Toxics staff.
[†] IRIS or PPRTV value obtained from USEPA Regional Screening Level table (May 2012)
N/A - Not Available
RfD - Reference Dose

Table C-1-3
Oral Slope Factors and Inhalation Unit Risk Factors for COCs
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Oral SF $(mg/kg\text{-}day)^{-1}$	Source for Oral SF[1]	URF $(ug/m3)^{-1}$	Source for URF[1]	Weight of Evidence
2-Methylphenol	95-48-7	N/A	7	N/A	7	C
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	N/A	N/A	N/A	N/A	N/A
Chloromethane	74-87-3	N/A	7	N/A	7	D
Trichlorofluoromethane	75-69-4	N/A	N/A	N/A	N/A	N/A

Note:
[7] Mass DEP. *MCP Numerical Standards Development Spreadsheets* . Retrieved August 2012, from http://www.mass.gov/dep/service/compliance/riskasmt.htm.
N/A - Not Available
SF - Slope Factor
URF - Unit Risk Factor
EPA Carcinogen Group:
C - Possible human carcinogen
D - Not classifiable as a human carcinogen

Table C-1-4
Relative Absorption Factors
Reichhold, Inc., Andover, Massachusetts

COC	CAS Number	Subchronic Exposures		Chronic Exposures		Carcinogenic Exposures	
		Soil Ingestion	Soil Dermal	Soil Ingestion	Soil Dermal	Soil Ingestion	Soil Dermal
2-Methylphenol	95-48-7	0.99	0.11	0.99	0.11	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	0.99	0.11	0.99	0.11	N/A	N/A
Chloromethane	74-87-3	0.99	0.11	0.99	0.11	N/A	N/A
Trichlorofluoromethane	75-69-4	0.99	0.11	0.99	0.11	N/A	N/A

Note:
N/A - Not Available (no Oral SF value)
RAFs were obtained from the Numerical Standards Spreadhseets (MADEP, Retrieved August 2012). If an RAF was not available in the Numerical Standards Spreadsheets, the default values were obtained from Appendix B-36 of the Guidance for Disposal Site Characterization (MADEP, 1995).

Table C-2-1
Calculation of Volatilization Factors
Reichhold, Inc., Andover, Massachusetts

Chemical	Diffusivity in Air (D_i) (cm^2/s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D_w) (cm^2/s)	Soil Organic Carbon Partition Coeff. (K_{oc}) (cm^3/g)	Solubility in Water (S) (mg/L)	Soil Water Partition Coeff. ($K_d = K_{oc} \times F_{oc}$) ($g/cm^3$)	Apparent Diffusivity (D_A) (cm^2/s)	Volatilization Factor (VF) (m^3/kg)	Reference
Chloromethane	1.3E-01	3.6E-01	6.5E-06	2.1E+00	5.3E+03	1.3E-02	1.3E-02	1.0E+03	J&E Model
Trichlorofluoromethane	8.7E-02	4.0E+00	9.7E-06	5.0E+02	1.1E+03	3.0E+00	4.8E-03	1.7E+03	J&E Model

Equations:

Volatilization factor (VF) = (m^3/kg)

$$VF = \frac{Q/C_{vol} * (3.14 * D_A * T)^{1/2} * 10^{-4}\ (m^2/cm^2)}{2 * r_b * D_A}$$

Apparent Diffusivity (D_A) = (cm^2/s)

$$D_A = \frac{[(Q_a^{10/3} * D_i * H' + Q_w^{10/3} * D_w)/n^2]}{(r_b * K_d + Q_w + Q_a * H')}$$

Parameters	Values
Q/C_{vol} - Inverse of the geometric mean air concentration to the volatilization flux at the center of a 0.5 acre-square source (g/m^2-s per kg/m^3)	65.36
T - Exposure interval(s)	9.5E+08
r_b - Soil bulk density (g/cm^3)	1.5
Q_a - Air-filled soil porosity (L_{air}/L_{soil}) = n - Q_w	0.28
n - Total soil porosity (L_{pore}/L_{soil}) = 1 - (r_b/r_s)	0.43
Q_w - Water-filled soil porosity (L_{water}/L_{soil})	0.15
r_s - Soil particle density (g/cm^3)	2.65
f_{oc} - fraction organic carbon in soil (g/g)	0.006

Note:

Q/C value for 0.5 acre source area in Zone 8, Hartford, Connecticut, from the Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24 (EPA, 2002).

SSL = Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24 (EPA, 2002). Chemical and physical properties from Exhibit C-1.

J&E Model = Johnson and Ettinger Model (USEPA, 2004). Chemical and physical properties from Johnson and Ettinger Model Vlookup Spreadsheet.

Table C-3-1
Future Land Use Scenario - Industrial Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	9.7E-08	1.1E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	9.7E-08	4.5E-07	1.0E-02	4.5E-05
2-Butanone	1.6E-02	1.0E+00	9.8E-08	1.6E-09	6.0E-01	2.6E-09
Acetone	9.2E-01	1.0E+00	9.8E-08	9.0E-08	9.0E-01	1.0E-07
Benzene	1.6E-03	1.0E+00	9.8E-08	1.6E-10	4.0E-03	3.9E-08
Ethylbenzene	9.2E-01	1.0E+00	9.8E-08	9.0E-08	1.0E-01	9.0E-07
Isopropylbenzene	1.1E-01	9.9E-01	9.7E-08	1.0E-08	1.0E-01	1.0E-07
n-Butylbenzene	1.4E+00	9.9E-01	9.7E-08	1.4E-07	5.0E-02	2.7E-06
n-Propylbenzene	3.7E-01	9.9E-01	9.7E-08	3.6E-08	1.0E-01	3.6E-07
Naphthalene	1.1E+00	3.6E-01	3.5E-08	3.9E-08	2.0E-02	2.0E-06
Methyl tert butyl ether	1.9E-01	1.0E+00	9.8E-08	1.8E-08	1.0E-01	1.8E-07
Methylene chloride	7.1E-01	1.0E+00	9.8E-08	7.0E-08	6.0E-03	1.2E-05
o-Xylene	1.4E+00	1.0E+00	9.8E-08	1.3E-07	2.0E-01	6.6E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	9.7E-08	1.0E-08	1.0E-01	1.0E-07
p/m-Xylene	6.7E+00	1.0E+00	9.8E-08	6.6E-07	2.0E-01	3.3E-06
Toluene	5.7E-02	1.0E+00	9.8E-08	5.6E-09	8.0E-02	7.0E-08
Total Xylenes	1.2E+00	1.0E+00	9.8E-08	1.2E-07	2.0E-01	5.9E-07
2,4-Dimethylphenol	2.0E+00	1.0E+00	9.8E-08	2.0E-07	2.0E-02	1.0E-05
3-Methylphenol/4-Methylphenol	9.2E-01	9.1E-01	8.9E-08	8.2E-08	5.0E-02	1.6E-06
Phenol	1.0E+00	1.0E+00	9.8E-08	1.0E-07	3.0E-01	3.4E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	9.8E-08	2.6E-08	2.0E-02	1.3E-06
Barium	2.6E+01	1.0E+00	9.8E-08	2.5E-06	2.0E-01	1.3E-05
Cadmium	3.1E+01	1.0E+00	9.8E-08	3.1E-06	1.0E-03	3.1E-03
Copper	2.2E+01	3.9E-01	3.8E-08	8.6E-07	4.0E-02	2.1E-05
Iron	1.0E+04	3.9E-01	3.8E-08	3.9E-04	7.0E-01	5.6E-04
Lead	7.2E+01	5.0E-01	4.9E-08	3.5E-06	7.5E-04	4.7E-03
Silver	2.9E-01	1.0E+00	9.8E-08	2.8E-08	5.0E-03	5.6E-06
Zinc	2.1E+03	1.0E+00	9.8E-08	2.1E-04	3.0E-01	6.9E-04
2-Methylphenol	9.8E-01	9.9E-01	9.7E-08	9.5E-08	5.0E-02	1.9E-06
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	9.9E-01	9.7E-08	3.9E-07	8.0E-05	4.8E-03
Chloromethane	9.8E-03	9.9E-01	9.7E-08	9.5E-10	N/A	N/A
Trichlorofluoromethane	3.6E-03	9.9E-01	9.7E-08	3.5E-10	3.0E-01	1.2E-09
Hazard Index						1E-02

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-3-2
Future Land Use Scenario - Industrial Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	1.0E+00	3.5E-08	5.6E-11	5.5E-02	3.1E-12
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	3.5E-08	2.5E-08	2.0E-03	5.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	3.5E-08	9.3E-09	1.4E-02	1.3E-10
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-10

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)
Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * .

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-3-3
Future Land Use Scenario - Industrial Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	2.2E-08	2.5E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	2.2E-08	1.0E-07	1.0E-02	1.0E-05
2-Butanone	1.6E-02	1.0E-01	2.0E-08	3.2E-10	6.0E-01	5.3E-10
Acetone	9.2E-01	1.0E-01	2.0E-08	1.8E-08	9.0E-01	2.0E-08
Benzene	1.6E-03	8.0E-02	1.6E-08	2.6E-11	4.0E-03	6.4E-09
Ethylbenzene	9.2E-01	2.0E-01	4.0E-08	3.7E-08	1.0E-01	3.7E-07
Isopropylbenzene	1.1E-01	1.1E-01	2.2E-08	2.4E-09	1.0E-01	2.4E-08
n-Butylbenzene	1.4E+00	1.1E-01	2.2E-08	3.1E-08	5.0E-02	6.2E-07
n-Propylbenzene	3.7E-01	1.1E-01	2.2E-08	8.3E-09	1.0E-01	8.3E-08
Naphthalene	1.1E+00	1.0E-01	2.0E-08	2.2E-08	2.0E-02	1.1E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	2.0E-08	3.7E-09	1.0E-01	3.7E-08
Methylene chloride	7.1E-01	1.0E-01	2.0E-08	1.4E-08	6.0E-03	2.4E-06
o-Xylene	1.4E+00	1.2E-01	2.4E-08	3.3E-08	2.0E-01	1.6E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	2.2E-08	2.3E-09	1.0E-01	2.3E-08
p/m-Xylene	6.7E+00	1.2E-01	2.4E-08	1.6E-07	2.0E-01	8.1E-07
Toluene	5.7E-02	1.2E-01	2.4E-08	1.4E-09	8.0E-02	1.7E-08
Total Xylenes	1.2E+00	1.2E-01	2.4E-08	2.9E-08	2.0E-01	1.5E-07
2,4-Dimethylphenol	2.0E+00	2.6E-01	5.2E-08	1.1E-07	2.0E-02	5.3E-06
3-Methylphenol/4-Methylphenol	9.2E-01	1.7E-01	3.4E-08	3.1E-08	5.0E-02	6.3E-07
Phenol	1.0E+00	2.6E-01	5.2E-08	5.4E-08	3.0E-01	1.8E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	4.0E-09	1.1E-09	2.0E-02	5.3E-08
Barium	2.6E+01	5.0E-02	1.0E-08	2.6E-07	2.0E-01	1.3E-06
Cadmium	3.1E+01	1.4E-01	2.8E-08	8.8E-07	1.0E-03	8.8E-04
Copper	2.2E+01	3.0E-02	6.0E-09	1.3E-07	4.0E-02	3.4E-06
Iron	1.0E+04	3.0E-02	6.0E-09	6.2E-05	7.0E-01	8.9E-05
Lead	7.2E+01	6.0E-03	1.2E-09	8.6E-08	7.5E-04	1.1E-04
Silver	2.9E-01	2.5E-01	5.0E-08	1.4E-08	5.0E-03	2.9E-06
Zinc	2.1E+03	2.0E-02	4.0E-09	8.5E-06	3.0E-01	2.8E-05
2-Methylphenol	9.8E-01	1.1E-01	2.2E-08	2.2E-08	5.0E-02	4.3E-07
4,6-Dinitro-2-methylphenol (4,6-Dinitro	4.0E+00	1.1E-01	2.2E-08	8.8E-08	8.0E-05	1.1E-03
Chloromethane	9.8E-03	1.1E-01	2.2E-08	2.2E-10	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.1E-01	2.2E-08	7.9E-11	3.0E-01	2.6E-10
Hazard Index						2E-03

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	9,855	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) /

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-3-4
Future Land Use Scenario - Industrial Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	8.0E-02	5.8E-09	9.2E-12	5.5E-02	5.1E-13
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	7.2E-09	5.1E-09	2.0E-03	1.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	1.4E-09	3.8E-10	1.4E-02	5.3E-12
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3411	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.03	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) /

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-3-5
Future Land Use Scenario - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	1.4E-01	1.1E-05	7.0E-03	1.6E-03
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	1.4E-01	1.1E-05	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	1.4E-01	1.1E-05	5.0E+00	2.1E-06
Acetone	9.2E-01	1.2E+04	8.5E-05	1.4E-01	1.2E-05	8.0E-01	1.5E-05
Benzene	1.6E-03	2.6E+03	3.9E-04	1.4E-01	5.3E-05	3.0E-02	1.8E-03
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	1.4E-01	2.7E-05	1.0E+00	2.7E-05
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	1.4E-01	1.8E-05	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	1.4E-01	2.3E-05	1.0E+00	2.3E-05
Naphthalene	1.1E+00	5.2E+04	1.9E-05	1.4E-01	2.6E-06	3.0E-03	8.7E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	1.4E-01	3.5E-05	3.0E+00	1.2E-05
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	1.4E-01	5.8E-05	6.0E-01	9.7E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	1.4E-01	2.4E-05	1.0E-01	2.4E-04
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	1.4E-01	1.3E-04	4.0E-01	3.4E-04
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
Toluene	5.7E-02	3.7E+03	2.7E-04	1.4E-01	3.7E-05	5.0E+00	7.3E-06
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	1.4E-01	2.6E-05	1.0E-01	2.6E-04
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	1.4E-01	8.9E-09	7.0E-02	1.3E-07
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	1.4E-01	4.0E-09	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	1.4E-01	4.6E-09	2.6E-01	1.8E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	1.4E-01	1.2E-09	7.0E-03	1.7E-07
Barium	2.6E+01	N/A	8.3E-07	1.4E-01	1.1E-07	5.0E-04	2.3E-04
Cadmium	3.1E+01	N/A	1.0E-06	1.4E-01	1.4E-07	2.0E-05	6.9E-03
Copper	2.2E+01	N/A	7.2E-07	1.4E-01	9.8E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	1.4E-01	4.5E-05	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	1.4E-01	3.1E-07	1.0E-03	3.1E-04
Silver	2.9E-01	N/A	9.2E-09	1.4E-01	1.3E-09	1.4E-04	9.0E-06
Zinc	2.1E+03	N/A	6.8E-05	1.4E-01	9.3E-06	1.4E-03	6.7E-03
2-Methylphenol	9.8E-01	N/A	3.1E-08	1.4E-01	4.3E-09	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	1.4E-01	1.7E-08	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	1.4E-01	1.3E-04	9.0E-02	1.5E-03
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	1.4E-01	8.0E-05	7.0E-01	1.1E-04
Hazard Index							2E-02

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	9,855	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

VF = Volatilization Factor

Table C-3-6
Future Land Use Scenario - Industrial Worker
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	4.9E-02	4.1E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	4.9E-02	4.0E-06	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	4.9E-02	3.9E-06	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	4.9E-02	4.2E-06	N/A	N/A
Benzene	1.6E-03	2.6E+03	3.9E-04	4.9E-02	1.9E-05	7.8E-03	1.5E-07
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	4.9E-02	9.7E-06	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	4.9E-02	6.4E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	4.9E-02	8.2E-06	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	4.9E-02	9.4E-07	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	4.9E-02	1.3E-05	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	4.9E-02	2.1E-05	1.0E-05	2.1E-10
o-Xylene	1.4E+00	5.8E+03	1.7E-04	4.9E-02	8.6E-06	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	4.9E-02	4.8E-05	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	4.9E-02	9.4E-06	N/A	N/A
Toluene	5.7E-02	3.7E+03	2.7E-04	4.9E-02	1.3E-05	N/A	N/A
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	4.9E-02	9.4E-06	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	4.9E-02	3.2E-09	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	4.9E-02	1.5E-09	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	4.9E-02	1.6E-09	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	4.9E-02	4.2E-10	1.3E-03	5.4E-13
Barium	2.6E+01	N/A	8.3E-07	4.9E-02	4.1E-08	N/A	N/A
Cadmium	3.1E+01	N/A	1.0E-06	4.9E-02	5.0E-08	1.8E+00	8.9E-08
Copper	2.2E+01	N/A	7.2E-07	4.9E-02	3.5E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	4.9E-02	1.6E-05	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	4.9E-02	1.1E-07	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	4.9E-02	4.5E-10	N/A	N/A
Zinc	2.1E+03	N/A	6.8E-05	4.9E-02	3.4E-06	N/A	N/A
2-Methylphenol	9.8E-01	N/A	3.1E-08	4.9E-02	1.6E-09	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	4.9E-02	6.3E-09	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	4.9E-02	4.8E-05	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	4.9E-02	2.9E-05	N/A	N/A
Cancer Risk							2E-07

EXPOSURE ASSUMPTIONS		
Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	150	(days/year)
Exposure Duration (ED)	27	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK
Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks
VF = Volatilization Factor

Table C-4-1
Future Land Use Scenario - Construction Worker
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	9.9E-01	4.1E-07	5.6E-05	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	4.1E-07	9.5E-07	9.0E-01	1.1E-06
1,3,5-Trimethylbenzene	4.6E+01	9.9E-01	4.1E-07	1.9E-05	1.0E-02	1.9E-03
1,4-Dichlorobenzene	1.3E+00	1.0E+00	4.1E-07	5.1E-07	9.0E-01	5.7E-07
2-Butanone	1.0E+01	1.0E+00	4.1E-07	4.3E-06	2.0E+00	2.1E-06
4-Methyl-2-pentanone	8.4E+00	1.0E+00	4.1E-07	3.5E-06	8.0E-01	4.3E-06
Acetone	8.7E+00	1.0E+00	4.1E-07	3.6E-06	1.0E+00	3.6E-06
Benzene	8.9E-01	1.0E+00	4.1E-07	3.6E-07	4.0E-03	9.1E-05
Carbon disulfide	1.5E+00	9.9E-01	4.1E-07	6.0E-07	1.0E-01	6.0E-06
Chlorobenzene	1.8E+00	1.0E+00	4.1E-07	7.3E-07	2.0E-01	3.7E-06
Ethylbenzene	6.2E+01	1.0E+00	4.1E-07	2.5E-05	1.0E+00	2.5E-05
Isopropylbenzene	1.9E+00	9.9E-01	4.1E-07	7.8E-07	1.0E-01	7.8E-06
n-Butylbenzene	1.0E+01	9.9E-01	4.1E-07	4.1E-06	5.0E-02	8.1E-05
n-Propylbenzene	4.1E+00	9.9E-01	4.1E-07	1.7E-06	1.0E-01	1.7E-05
Naphthalene	9.5E+00	3.6E-01	1.5E-07	1.4E-06	2.0E-02	7.0E-05
Methyl tert butyl ether	1.1E+00	1.0E+00	4.1E-07	4.3E-07	1.0E+00	4.3E-07
Methylene chloride	5.1E+00	1.0E+00	4.1E-07	2.1E-06	6.0E-02	3.5E-05
o-Xylene	1.1E+01	1.0E+00	4.1E-07	4.5E-06	2.0E-01	2.3E-05
p-Isopropyltoluene	1.7E+00	9.9E-01	4.1E-07	6.7E-07	1.0E-01	6.7E-06
p/m-Xylene	6.2E+01	1.0E+00	4.1E-07	2.5E-05	2.0E-01	1.3E-04
sec-Butylbenzene	1.2E+00	9.9E-01	4.1E-07	4.9E-07	N/A	N/A
Styrene	5.6E+00	1.0E+00	4.1E-07	2.3E-06	2.0E+00	1.1E-06
Toluene	1.9E+00	1.0E+00	4.1E-07	8.0E-07	8.0E-02	1.0E-05
Total Xylenes	1.2E+02	1.0E+00	4.1E-07	5.0E-05	2.0E-01	2.5E-04
2,4-Dimethylphenol	4.2E-01	1.0E+00	4.1E-07	1.7E-07	2.0E-01	8.7E-07
3-Methylphenol/4-Methylphenol	9.2E-01	9.1E-01	3.7E-07	3.4E-07	5.0E-02	6.9E-06
Phenol	1.3E+01	1.0E+00	4.1E-07	5.3E-06	3.0E-01	1.8E-05
2-Methylnaphthalene	1.2E+00	3.6E-01	1.5E-07	1.7E-07	4.0E-03	4.3E-05
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	4.1E-07	1.1E-07	2.0E-02	5.7E-06
Dibenzofuran	3.0E-01	9.1E-01	3.7E-07	1.1E-07	1.0E-03	1.1E-04
Phenanthrene	6.1E-01	3.6E-01	1.5E-07	9.0E-08	3.0E-01	3.0E-07
Arsenic	7.8E+00	1.0E+00	4.1E-07	3.2E-06	3.0E-04	1.1E-02
Barium	2.2E+01	1.0E+00	4.1E-07	9.1E-06	7.0E-02	1.3E-04
Cadmium	2.9E+00	1.0E+00	4.1E-07	1.2E-06	1.0E-03	1.2E-03
Chromium	1.7E+01	1.0E+00	4.1E-07	6.9E-06	2.0E-02	3.5E-04
Copper	2.0E+01	3.9E-01	1.6E-07	3.2E-06	4.0E-02	8.0E-05
Iron	9.5E+03	3.9E-01	1.6E-07	1.5E-03	7.0E-01	2.2E-03
Lead	2.3E+01	5.0E-01	2.1E-07	4.8E-06	7.5E-04	6.3E-03
Silver	3.0E-01	1.0E+00	4.1E-07	1.2E-07	5.0E-03	2.5E-05
Zinc	5.7E+02	1.0E+00	4.1E-07	2.4E-04	3.0E-01	7.8E-04
2-Methylphenol	9.3E-01	9.9E-01	4.1E-07	3.8E-07	5.0E-02	7.6E-06
Hazard Index						2E-02

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-4-2
Future Land Use Scenario - Construction Worker
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	2.7E-09	3.4E-09	2.4E-02	8.2E-11
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	2.7E-09	2.4E-09	5.5E-02	1.3E-10
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	6.2E+01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	2.7E-09	1.4E-08	2.0E-03	2.8E-11
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	2.7E-09	1.5E-08	3.0E-02	4.6E-10
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.7E-09	7.5E-10	1.4E-02	1.1E-11
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	2.7E-09	2.1E-08	1.5E+00	3.2E-08
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	2.9E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.0E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	5.7E+02	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.3E-01	N/A	N/A	N/A	N/A	N/A
Cancer Risk						3E-08

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	100	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-4-3
Future Land Use Scenario - Construction Worker
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.1E-01	4.5E-07	6.2E-05	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E-01	4.1E-07	9.6E-07	9.0E-01	1.1E-06
1,3,5-Trimethylbenzene	4.6E+01	1.1E-01	4.5E-07	2.1E-05	1.0E-02	2.1E-03
1,4-Dichlorobenzene	1.3E+00	1.0E-01	4.1E-07	5.2E-07	9.0E-01	5.7E-07
2-Butanone	1.0E+01	1.0E-01	4.1E-07	4.3E-06	2.0E+00	2.2E-06
4-Methyl-2-pentanone	8.4E+00	1.0E-01	4.1E-07	3.5E-06	8.0E-01	4.3E-06
Acetone	8.7E+00	1.0E-01	4.1E-07	3.6E-06	1.0E+00	3.6E-06
Benzene	8.9E-01	8.0E-02	3.3E-07	2.9E-07	4.0E-03	7.3E-05
Carbon disulfide	1.5E+00	1.1E-01	4.5E-07	6.7E-07	1.0E-01	6.7E-06
Chlorobenzene	1.8E+00	1.0E-01	4.1E-07	7.4E-07	2.0E-01	3.7E-06
Ethylbenzene	6.2E+01	2.0E-01	8.3E-07	5.1E-05	1.0E+00	5.1E-05
Isopropylbenzene	1.9E+00	1.1E-01	4.5E-07	8.7E-07	1.0E-01	8.7E-06
n-Butylbenzene	1.0E+01	1.1E-01	4.5E-07	4.6E-06	5.0E-02	9.1E-05
n-Propylbenzene	4.1E+00	1.1E-01	4.5E-07	1.9E-06	1.0E-01	1.9E-05
Naphthalene	9.5E+00	1.0E-01	4.1E-07	3.9E-06	2.0E-02	2.0E-04
Methyl tert butyl ether	1.1E+00	1.0E-01	4.1E-07	4.4E-07	1.0E+00	4.4E-07
Methylene chloride	5.1E+00	1.0E-01	4.1E-07	2.1E-06	6.0E-02	3.5E-05
o-Xylene	1.1E+01	1.2E-01	5.0E-07	5.4E-06	2.0E-01	2.7E-05
p-Isopropyltoluene	1.7E+00	1.1E-01	4.5E-07	7.5E-07	1.0E-01	7.5E-06
p/m-Xylene	6.2E+01	1.2E-01	5.0E-07	3.1E-05	2.0E-01	1.5E-04
sec-Butylbenzene	1.2E+00	1.1E-01	4.5E-07	5.5E-07	N/A	N/A
Styrene	5.6E+00	2.0E-01	8.3E-07	4.6E-06	2.0E+00	2.3E-06
Toluene	1.9E+00	1.2E-01	5.0E-07	9.7E-07	8.0E-02	1.2E-05
Total Xylenes	1.2E+02	1.2E-01	5.0E-07	6.0E-05	2.0E-01	3.0E-04
2,4-Dimethylphenol	4.2E-01	2.6E-01	1.1E-06	4.6E-07	2.0E-01	2.3E-06
3-Methylphenol/4-Methylphenol	9.2E-01	1.7E-01	7.0E-07	6.5E-07	5.0E-02	1.3E-05
Phenol	1.3E+01	2.6E-01	1.1E-06	1.4E-05	3.0E-01	4.7E-05
2-Methylnaphthalene	1.2E+00	1.0E-01	4.1E-07	4.8E-07	4.0E-03	1.2E-04
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	8.3E-08	2.3E-08	2.0E-02	1.1E-06
Dibenzofuran	3.0E-01	1.7E-01	7.0E-07	2.1E-07	1.0E-03	2.1E-04
Phenanthrene	6.1E-01	1.0E-01	4.1E-07	2.5E-07	3.0E-01	8.4E-07
Arsenic	7.8E+00	3.0E-02	1.2E-07	9.7E-07	3.0E-04	3.2E-03
Barium	2.2E+01	5.0E-02	2.1E-07	4.6E-06	7.0E-02	6.5E-05
Cadmium	2.9E+00	1.4E-01	5.8E-07	1.7E-06	1.0E-03	1.7E-03
Chromium	1.7E+01	9.0E-02	3.7E-07	6.3E-06	2.0E-02	3.1E-04
Copper	2.0E+01	3.0E-02	1.2E-07	2.5E-06	4.0E-02	6.2E-05
Iron	9.5E+03	3.0E-02	1.2E-07	1.2E-03	7.0E-01	1.7E-03
Lead	2.3E+01	6.0E-03	2.5E-08	5.8E-07	7.5E-04	7.7E-04
Silver	3.0E-01	2.5E-01	1.0E-06	3.1E-07	5.0E-03	6.2E-05
Zinc	5.7E+02	2.0E-02	8.3E-08	4.7E-05	3.0E-01	1.6E-04
2-Methylphenol	9.3E-01	1.1E-01	4.5E-07	4.2E-07	5.0E-02	8.5E-06
Hazard Index						1E-02

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-4-4
Future Land Use Scenario - Construction Worker
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E-01	2.7E-09	3.4E-09	2.4E-02	8.3E-11
2-Butanone	1.0E+01	N/A	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	N/A	N/A	N/A	N/A
Benzene	8.9E-01	8.0E-02	2.2E-09	1.9E-09	5.5E-02	1.1E-10
Carbon disulfide	1.5E+00	N/A	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	6.2E+01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E-01	2.7E-09	1.4E-08	2.0E-03	2.8E-11
o-Xylene	1.1E+01	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	N/A	N/A	N/A	N/A
Styrene	5.6E+00	2.0E-01	5.5E-09	3.1E-08	3.0E-02	9.2E-10
Toluene	1.9E+00	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	2.0E-02	5.5E-10	1.5E-10	1.4E-02	2.1E-12
Dibenzofuran	3.0E-01	N/A	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	3.0E-02	8.2E-10	6.4E-09	1.5E+00	9.6E-09
Barium	2.2E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	2.9E+00	N/A	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.0E+01	N/A	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	N/A	N/A	N/A	N/A
Zinc	5.7E+02	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.3E-01	N/A	N/A	N/A	N/A	N/A
Cancer Risk						1E-08

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	3473	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.29	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-4-5
Future Land Use Scenario - Construction Worker
Ingestion of Inhaled Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	9.9E-01	1.2E-05	3.5E-01	4.3E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	2.1E-07	3.5E-01	7.4E-08	9.0E-01	8.2E-08
1,3,5-Trimethylbenzene	4.6E+01	9.9E-01	4.1E-06	3.5E-01	1.4E-06	1.0E-02	1.4E-04
1,4-Dichlorobenzene	1.3E+00	1.0E+00	1.1E-07	3.5E-01	4.0E-08	9.0E-01	4.4E-08
2-Butanone	1.0E+01	1.0E+00	9.4E-07	3.5E-01	3.3E-07	2.0E+00	1.7E-07
4-Methyl-2-pentanone	8.4E+00	1.0E+00	7.6E-07	3.5E-01	2.7E-07	8.0E-01	3.4E-07
Acetone	8.7E+00	1.0E+00	7.8E-07	3.5E-01	2.8E-07	1.0E+00	2.8E-07
Benzene	8.9E-01	1.0E+00	8.0E-08	3.5E-01	2.8E-08	4.0E-03	7.1E-06
Carbon disulfide	1.5E+00	9.9E-01	1.3E-07	3.5E-01	4.7E-08	1.0E-01	4.7E-07
Chlorobenzene	1.8E+00	1.0E+00	1.6E-07	3.5E-01	5.7E-08	2.0E-01	2.8E-07
Ethylbenzene	6.2E+01	1.0E+00	5.5E-06	3.5E-01	2.0E-06	1.0E+00	2.0E-06
Isopropylbenzene	1.9E+00	9.9E-01	1.7E-07	3.5E-01	6.0E-08	1.0E-01	6.0E-07
n-Butylbenzene	1.0E+01	9.9E-01	9.0E-07	3.5E-01	3.2E-07	5.0E-02	6.3E-06
n-Propylbenzene	4.1E+00	9.9E-01	3.7E-07	3.5E-01	1.3E-07	1.0E-01	1.3E-06
Naphthalene	9.5E+00	3.6E-01	8.6E-07	1.3E-01	1.1E-07	2.0E-02	5.5E-06
Methyl tert butyl ether	1.1E+00	1.0E+00	9.5E-08	3.5E-01	3.4E-08	1.0E+00	3.4E-08
Methylene chloride	5.1E+00	1.0E+00	4.6E-07	3.5E-01	1.6E-07	6.0E-02	2.7E-06
o-Xylene	1.1E+01	1.0E+00	9.9E-07	3.5E-01	3.5E-07	2.0E-01	1.8E-06
p-Isopropyltoluene	1.7E+00	9.9E-01	1.5E-07	3.5E-01	5.2E-08	1.0E-01	5.2E-07
p/m-Xylene	6.2E+01	1.0E+00	5.6E-06	3.5E-01	2.0E-06	2.0E-01	9.9E-06
sec-Butylbenzene	1.2E+00	9.9E-01	1.1E-07	3.5E-01	3.8E-08	N/A	N/A
Styrene	5.6E+00	1.0E+00	5.0E-07	3.5E-01	1.8E-07	2.0E+00	8.9E-08
Toluene	1.9E+00	1.0E+00	1.8E-07	3.5E-01	6.2E-08	8.0E-02	7.8E-07
Total Xylenes	1.2E+02	1.0E+00	1.1E-05	3.5E-01	3.9E-06	2.0E-01	1.9E-05
2,4-Dimethylphenol	4.2E-01	1.0E+00	3.8E-08	3.5E-01	1.4E-08	2.0E-01	6.8E-08
3-Methylphenol/4-Methylphenol	9.2E-01	9.1E-01	8.3E-08	3.2E-01	2.7E-08	5.0E-02	5.3E-07
Phenol	1.3E+01	1.0E+00	1.2E-06	3.5E-01	4.1E-07	3.0E-01	1.4E-06
2-Methylnaphthalene	1.2E+00	3.6E-01	1.0E-07	1.3E-01	1.3E-08	4.0E-03	3.3E-06
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.5E-08	3.5E-01	8.8E-09	2.0E-02	4.4E-07
Dibenzofuran	3.0E-01	9.1E-01	2.7E-08	3.2E-01	8.7E-09	1.0E-03	8.7E-06
Phenanthrene	6.1E-01	3.6E-01	5.5E-08	1.3E-01	7.0E-09	3.0E-01	2.3E-08
Arsenic	7.8E+00	1.0E+00	7.0E-07	3.5E-01	2.5E-07	3.0E-04	8.3E-04
Barium	2.2E+01	1.0E+00	2.0E-06	3.5E-01	7.1E-07	7.0E-02	1.0E-05
Cadmium	2.9E+00	1.0E+00	2.6E-07	3.5E-01	9.2E-08	1.0E-03	9.2E-05
Chromium	1.7E+01	1.0E+00	1.5E-06	3.5E-01	5.4E-07	2.0E-02	2.7E-05
Copper	2.0E+01	3.9E-01	1.8E-06	1.4E-01	2.5E-07	4.0E-02	6.2E-06
Iron	9.5E+03	3.9E-01	8.5E-04	1.4E-01	1.2E-04	7.0E-01	1.7E-04
Lead	2.3E+01	5.0E-01	2.1E-06	1.8E-01	3.7E-07	7.5E-04	4.9E-04
Silver	3.0E-01	1.0E+00	2.7E-08	3.5E-01	9.6E-09	5.0E-03	1.9E-06
Zinc	5.7E+02	1.0E+00	5.2E-05	3.5E-01	1.8E-05	3.0E-01	6.1E-05
2-Methylphenol	9.3E-01	9.9E-01	8.4E-08	3.5E-01	2.9E-08	5.0E-02	5.9E-07
Hazard Index							2E-03

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-4-6
Future Land Use Scenario - Construction Worker
Ingestion of Inhaled Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	$ADD_{inhal-GI}$ (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	N/A	1.2E-05	N/A	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	N/A	2.1E-07	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	N/A	4.1E-06	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	1.1E-07	2.4E-03	2.7E-10	2.4E-02	6.4E-12
2-Butanone	1.0E+01	N/A	9.4E-07	N/A	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	N/A	7.6E-07	N/A	N/A	N/A	N/A
Acetone	8.7E+00	N/A	7.8E-07	N/A	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	8.0E-08	2.4E-03	1.9E-10	5.5E-02	1.0E-11
Carbon disulfide	1.5E+00	N/A	1.3E-07	N/A	N/A	N/A	N/A
Chlorobenzene	1.8E+00	N/A	1.6E-07	N/A	N/A	N/A	N/A
Ethylbenzene	6.2E+01	N/A	5.5E-06	N/A	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	N/A	1.7E-07	N/A	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	N/A	9.0E-07	N/A	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	N/A	3.7E-07	N/A	N/A	N/A	N/A
Naphthalene	9.5E+00	N/A	8.6E-07	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	N/A	9.5E-08	N/A	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	4.6E-07	2.4E-03	1.1E-09	2.0E-03	2.2E-12
o-Xylene	1.1E+01	N/A	9.9E-07	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	N/A	1.5E-07	N/A	N/A	N/A	N/A
p/m-Xylene	6.2E+01	N/A	5.6E-06	N/A	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	N/A	1.1E-07	N/A	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	5.0E-07	2.4E-03	1.2E-09	3.0E-02	3.6E-11
Toluene	1.9E+00	N/A	1.8E-07	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+02	N/A	1.1E-05	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	N/A	3.8E-08	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	8.3E-08	N/A	N/A	N/A	N/A
Phenol	1.3E+01	N/A	1.2E-06	N/A	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	N/A	1.0E-07	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	2.5E-08	2.4E-03	5.9E-11	1.4E-02	8.2E-13
Dibenzofuran	3.0E-01	N/A	2.7E-08	N/A	N/A	N/A	N/A
Phenanthrene	6.1E-01	N/A	5.5E-08	N/A	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	7.0E-07	2.4E-03	1.7E-09	1.5E+00	2.5E-09
Barium	2.2E+01	N/A	2.0E-06	N/A	N/A	N/A	N/A
Cadmium	2.9E+00	N/A	2.6E-07	N/A	N/A	N/A	N/A
Chromium	1.7E+01	N/A	1.5E-06	N/A	N/A	N/A	N/A
Copper	2.0E+01	N/A	1.8E-06	N/A	N/A	N/A	N/A
Iron	9.5E+03	N/A	8.5E-04	N/A	N/A	N/A	N/A
Lead	2.3E+01	N/A	2.1E-06	N/A	N/A	N/A	N/A
Silver	3.0E-01	N/A	2.7E-08	N/A	N/A	N/A	N/A
Zinc	5.7E+02	N/A	5.2E-05	N/A	N/A	N/A	N/A
2-Methylphenol	9.3E-01	N/A	8.4E-08	N/A	N/A	N/A	N/A
Cancer Risk							3E-09

EXPOSURE ASSUMPTIONS

PM-10	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 1.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

$ADD_{inhal-GI}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-4-7
Future Land Use Scenario - Construction Worker
Inhalation of Airborne Particulates from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD$_{inhal}$ (mg/kg/day)	RfC (mg/m^3)	RFD$_{inhal}$ (mg/kg/day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.0E+00	4.1E-06	3.5E-01	1.5E-06	7.0E-03	2.0E-03	7.3E-04
1,2-Dichlorobenzene	2.3E+00	1.0E+00	6.9E-08	3.5E-01	2.5E-08	2.0E-01	5.7E-02	4.3E-07
1,3,5-Trimethylbenzene	4.6E+01	1.0E+00	1.4E-06	3.5E-01	4.9E-07	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	3.8E-08	3.5E-01	1.3E-08	8.0E-01	2.3E-01	5.8E-08
2-Butanone	1.0E+01	1.0E+00	3.1E-07	3.5E-01	1.1E-07	5.0E+00	1.4E+00	7.8E-08
4-Methyl-2-pentanone	8.4E+00	1.0E+00	2.5E-07	3.5E-01	8.9E-08	3.0E+00	8.6E-01	1.0E-07
Acetone	8.7E+00	1.0E+00	2.6E-07	3.5E-01	9.2E-08	8.0E-01	2.3E-01	4.0E-07
Benzene	8.9E-01	1.0E+00	2.7E-08	3.5E-01	9.4E-09	3.0E-02	8.6E-03	1.1E-06
Carbon disulfide	1.5E+00	1.0E+00	4.5E-08	3.5E-01	1.6E-08	7.0E-01	2.0E-01	7.9E-08
Chlorobenzene	1.8E+00	1.0E+00	5.3E-08	3.5E-01	1.9E-08	5.0E-02	1.4E-02	1.3E-06
Ethylbenzene	6.2E+01	1.0E+00	1.8E-06	3.5E-01	6.6E-07	1.0E+00	2.9E-01	2.3E-06
Isopropylbenzene	1.9E+00	1.0E+00	5.7E-08	3.5E-01	2.0E-08	4.0E-01	1.1E-01	1.8E-07
n-Butylbenzene	1.0E+01	1.0E+00	3.0E-07	3.5E-01	1.1E-07	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	1.0E+00	1.2E-07	3.5E-01	4.4E-08	1.0E+00	2.9E-01	1.5E-07
Naphthalene	9.5E+00	1.0E+00	2.9E-07	3.5E-01	1.0E-07	3.0E-03	8.6E-04	1.2E-04
Methyl tert butyl ether	1.1E+00	1.0E+00	3.2E-08	3.5E-01	1.1E-08	3.0E+00	8.6E-01	1.3E-08
Methylene chloride	5.1E+00	1.0E+00	1.5E-07	3.5E-01	5.4E-08	3.0E+00	8.6E-01	6.4E-08
o-Xylene	1.1E+01	1.0E+00	3.3E-07	3.5E-01	1.2E-07	1.0E-01	2.9E-02	4.1E-06
p-Isopropyltoluene	1.7E+00	1.0E+00	5.0E-08	3.5E-01	1.8E-08	4.0E-01	1.1E-01	1.5E-07
p/m-Xylene	6.2E+01	1.0E+00	1.9E-06	3.5E-01	6.6E-07	1.0E-01	2.9E-02	2.3E-05
sec-Butylbenzene	1.2E+00	1.0E+00	3.6E-08	3.5E-01	1.3E-08	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	1.7E-07	3.5E-01	5.9E-08	3.0E+00	8.6E-01	6.9E-08
Toluene	1.9E+00	1.0E+00	5.8E-08	3.5E-01	2.1E-08	5.0E+00	1.4E+00	1.5E-08
Total Xylenes	1.2E+02	1.0E+00	3.6E-06	3.5E-01	1.3E-06	1.0E-01	2.9E-02	4.5E-05
2,4-Dimethylphenol	4.2E-01	1.0E+00	1.3E-08	3.5E-01	4.5E-09	7.0E-01	2.0E-01	2.3E-08
3-Methylphenol/4-Methylphenol	9.2E-01	1.0E+00	2.8E-08	3.5E-01	9.8E-09	N/A	N/A	N/A
Phenol	1.3E+01	1.0E+00	3.9E-07	3.5E-01	1.4E-07	2.6E-01	7.4E-02	1.9E-06
2-Methylnaphthalene	1.2E+00	1.0E+00	3.5E-08	3.5E-01	1.2E-08	5.0E-01	1.4E-01	8.6E-08
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	8.3E-09	3.5E-01	2.9E-09	7.0E-03	2.0E-03	1.5E-06
Dibenzofuran	3.0E-01	1.0E+00	9.0E-09	3.5E-01	3.2E-09	N/A	N/A	N/A
Phenanthrene	6.1E-01	1.0E+00	1.8E-08	3.5E-01	6.5E-09	5.0E-01	1.4E-01	4.5E-08
Arsenic	7.8E+00	1.0E+00	2.3E-07	3.5E-01	8.3E-08	2.5E-06	7.1E-07	1.2E-01
Barium	2.2E+01	1.0E+00	6.6E-07	3.5E-01	2.4E-07	5.0E-03	1.4E-03	1.6E-04
Cadmium	2.9E+00	1.0E+00	8.6E-08	3.5E-01	3.1E-08	2.0E-05	5.7E-06	5.3E-03
Chromium	1.7E+01	1.0E+00	5.1E-07	3.5E-01	1.8E-07	1.0E-04	2.9E-05	6.3E-03
Copper	2.0E+01	1.0E+00	6.0E-07	3.5E-01	2.1E-07	N/A	N/A	N/A
Iron	9.5E+03	1.0E+00	2.8E-04	3.5E-01	1.0E-04	N/A	N/A	N/A
Lead	2.3E+01	1.0E+00	7.0E-07	3.5E-01	2.5E-07	1.0E-03	2.9E-04	8.6E-04
Silver	3.0E-01	1.0E+00	9.0E-09	3.5E-01	3.2E-09	1.4E-04	4.0E-05	8.0E-05
Zinc	5.7E+02	1.0E+00	1.7E-05	3.5E-01	6.1E-06	1.4E-03	4.0E-04	1.5E-02
2-Methylphenol	9.3E-01	1.0E+00	2.8E-08	3.5E-01	9.9E-09	N/A	N/A	N/A
Hazard Index								1E-01

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD$_{inhal}$ =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION

RfD$_{inhal}$ = [RfC *INH (20 m^3/day)] / BW (70 kg)

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table C-4-8
Future Land Use Scenario - Construction Worker
Inhalation of Airborne Particulates from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Conc. in Air (mg/m^3)	Exposure Factor (m^3/kg-day)	ADD_{inhal} (mg/kg/day)	Unit Risk $(mg/m^3)^{-1}$	CSF_{inhal} (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	1.0E+00	4.1E-06	2.4E-03	9.7E-09	N/A	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.0E+00	6.9E-08	2.4E-03	1.6E-10	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	1.0E+00	1.4E-06	2.4E-03	3.2E-09	N/A	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.0E+00	3.8E-08	2.4E-03	8.8E-11	6.9E-03	2.4E-02	2.1E-12
2-Butanone	1.0E+01	1.0E+00	3.1E-07	2.4E-03	7.4E-10	N/A	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	1.0E+00	2.5E-07	2.4E-03	5.9E-10	N/A	N/A	N/A
Acetone	8.7E+00	1.0E+00	2.6E-07	2.4E-03	6.1E-10	N/A	N/A	N/A
Benzene	8.9E-01	1.0E+00	2.7E-08	2.4E-03	6.3E-11	7.8E-03	2.7E-02	1.7E-12
Carbon disulfide	1.5E+00	1.0E+00	4.5E-08	2.4E-03	1.0E-10	N/A	N/A	N/A
Chlorobenzene	1.8E+00	1.0E+00	5.3E-08	2.4E-03	1.3E-10	N/A	N/A	N/A
Ethylbenzene	6.2E+01	1.0E+00	1.8E-06	2.4E-03	4.4E-09	N/A	N/A	N/A
Isopropylbenzene	1.9E+00	1.0E+00	5.7E-08	2.4E-03	1.3E-10	N/A	N/A	N/A
n-Butylbenzene	1.0E+01	1.0E+00	3.0E-07	2.4E-03	7.1E-10	N/A	N/A	N/A
n-Propylbenzene	4.1E+00	1.0E+00	1.2E-07	2.4E-03	2.9E-10	N/A	N/A	N/A
Naphthalene	9.5E+00	1.0E+00	2.9E-07	2.4E-03	6.7E-10	N/A	N/A	N/A
Methyl tert butyl ether	1.1E+00	1.0E+00	3.2E-08	2.4E-03	7.5E-11	N/A	N/A	N/A
Methylene chloride	5.1E+00	1.0E+00	1.5E-07	2.4E-03	3.6E-10	1.0E-05	3.5E-05	1.3E-14
o-Xylene	1.1E+01	1.0E+00	3.3E-07	2.4E-03	7.8E-10	N/A	N/A	N/A
p-Isopropyltoluene	1.7E+00	1.0E+00	5.0E-08	2.4E-03	1.2E-10	N/A	N/A	N/A
p/m-Xylene	6.2E+01	1.0E+00	1.9E-06	2.4E-03	4.4E-09	N/A	N/A	N/A
sec-Butylbenzene	1.2E+00	1.0E+00	3.6E-08	2.4E-03	8.5E-11	N/A	N/A	N/A
Styrene	5.6E+00	1.0E+00	1.7E-07	2.4E-03	4.0E-10	5.7E-04	2.0E-03	7.9E-13
Toluene	1.9E+00	1.0E+00	5.8E-08	2.4E-03	1.4E-10	N/A	N/A	N/A
Total Xylenes	1.2E+02	1.0E+00	3.6E-06	2.4E-03	8.5E-09	N/A	N/A	N/A
2,4-Dimethylphenol	4.2E-01	1.0E+00	1.3E-08	2.4E-03	3.0E-11	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	1.0E+00	2.8E-08	2.4E-03	6.5E-11	N/A	N/A	N/A
Phenol	1.3E+01	1.0E+00	3.9E-07	2.4E-03	9.2E-10	N/A	N/A	N/A
2-Methylnaphthalene	1.2E+00	1.0E+00	3.5E-08	2.4E-03	8.2E-11	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.8E-01	1.0E+00	8.3E-09	2.4E-03	2.0E-11	1.3E-03	4.6E-03	8.9E-14
Dibenzofuran	3.0E-01	1.0E+00	9.0E-09	2.4E-03	2.1E-11	N/A	N/A	N/A
Phenanthrene	6.1E-01	1.0E+00	1.8E-08	2.4E-03	4.3E-11	N/A	N/A	N/A
Arsenic	7.8E+00	1.0E+00	2.3E-07	2.4E-03	5.5E-10	4.3E+00	1.5E+01	8.3E-09
Barium	2.2E+01	1.0E+00	6.6E-07	2.4E-03	1.6E-09	N/A	N/A	N/A
Cadmium	2.9E+00	1.0E+00	8.6E-08	2.4E-03	2.0E-10	1.8E+00	6.3E+00	1.3E-09
Chromium	1.7E+01	1.0E+00	5.1E-07	2.4E-03	1.2E-09	1.2E+01	4.2E+01	5.0E-08
Copper	2.0E+01	1.0E+00	6.0E-07	2.4E-03	1.4E-09	N/A	N/A	N/A
Iron	9.5E+03	1.0E+00	2.8E-04	2.4E-03	6.7E-07	N/A	N/A	N/A
Lead	2.3E+01	1.0E+00	7.0E-07	2.4E-03	1.6E-09	N/A	N/A	N/A
Silver	3.0E-01	1.0E+00	9.0E-09	2.4E-03	2.1E-11	N/A	N/A	N/A
Zinc	5.7E+02	1.0E+00	1.7E-05	2.4E-03	4.1E-08	N/A	N/A	N/A
2-Methylphenol	9.3E-01	1.0E+00	2.8E-08	2.4E-03	6.6E-11	N/A	N/A	N/A
Cancer Risk								6E-08

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Inhalation Rate (Inh)	60	(l/min)
Number of Exposure Event (EF)	1	(event/day)
Exposure Duration (ED)	8	(hours/event)
Exposure Period (EP)	130	(days)
Body Weight (BW)	58	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * 0.5 * PM-10 *CF1

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(INH * RAF * EF * ED * EP * CF3) / (BW * AT)]

TOXICITY VALUE CONVERSION

CSF_{inhal} = [CSF_{oral} * BW (70 kg)] / INH (20 m^3/day)

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

Table C-4-9
Future Land Use Scenario - Construction Worker
Inhalation of Airborne Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	6.9E-04	2.4E-01	1.6E-04	7.0E-03	2.3E-02
1,2-Dichlorobenzene	2.3E+00	1.4E+04	1.0E-05	2.4E-01	2.4E-06	2.0E-01	1.2E-05
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	2.2E-04	2.4E-01	5.3E-05	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	6.2E-06	2.4E-01	1.5E-06	8.0E-01	1.8E-06
2-Butanone	1.0E+01	1.3E+04	4.9E-05	2.4E-01	1.2E-05	5.0E+00	2.3E-06
4-Methyl-2-pentanone	8.4E+00	9.9E+03	5.1E-05	2.4E-01	1.2E-05	3.0E+00	4.1E-06
Acetone	8.7E+00	1.2E+04	4.4E-05	2.4E-01	1.1E-05	8.0E-01	1.3E-05
Benzene	8.9E-01	2.6E+03	2.1E-05	2.4E-01	4.9E-06	3.0E-02	1.6E-04
Carbon disulfide	1.5E+00	1.1E+03	7.9E-05	2.4E-01	1.9E-05	7.0E-01	2.7E-05
Chlorobenzene	1.8E+00	5.9E+03	1.8E-05	2.4E-01	4.3E-06	5.0E-02	8.7E-05
Ethylbenzene	6.2E+01	5.1E+03	7.3E-04	2.4E-01	1.7E-04	1.0E+00	1.7E-04
Isopropylbenzene	1.9E+00	1.0E+03	1.1E-04	2.4E-01	2.7E-05	4.0E-01	6.7E-05
n-Butylbenzene	1.0E+01	7.7E+03	7.8E-05	2.4E-01	1.9E-05	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	4.1E-05	2.4E-01	9.8E-06	1.0E+00	9.8E-06
Naphthalene	9.5E+00	5.2E+04	1.1E-05	2.4E-01	2.6E-06	3.0E-03	8.6E-04
Methyl tert butyl ether	1.1E+00	3.9E+03	1.6E-05	2.4E-01	3.9E-06	3.0E+00	1.3E-06
Methylene chloride	5.1E+00	2.3E+03	1.3E-04	2.4E-01	3.1E-05	3.0E+00	1.0E-05
o-Xylene	1.1E+01	5.8E+03	1.1E-04	2.4E-01	2.7E-05	1.0E-01	2.7E-04
p-Isopropyltoluene	1.7E+00	1.0E+03	9.7E-05	2.4E-01	2.3E-05	4.0E-01	5.8E-05
p/m-Xylene	6.2E+01	5.2E+03	7.1E-04	2.4E-01	1.7E-04	1.0E-01	1.7E-03
sec-Butylbenzene	1.2E+00	7.0E+03	1.0E-05	2.4E-01	2.4E-06	N/A	N/A
Styrene	5.6E+00	1.3E+04	2.7E-05	2.4E-01	6.3E-06	3.0E+00	2.1E-06
Toluene	1.9E+00	3.7E+03	3.1E-05	2.4E-01	7.5E-06	5.0E+00	1.5E-06
Total Xylenes	1.2E+02	5.2E+03	1.4E-03	2.4E-01	3.3E-04	1.0E-01	3.3E-03
Hazard Index							3E-02

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 3 (CF3)	0.060	(min-m^3/hr-l)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	182	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs

RfC = Reference Concentration

VF = Volatilization Factor

Table C-4-10
Future Land Use Scenario - Construction Worker
Inhalation of Airborne Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADD_{inhal} (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.4E+02	1.2E+04	6.9E-04	1.6E-03	1.1E-06	N/A	N/A
1,2-Dichlorobenzene	2.3E+00	1.4E+04	1.0E-05	1.6E-03	1.6E-08	N/A	N/A
1,3,5-Trimethylbenzene	4.6E+01	1.2E+04	2.2E-04	1.6E-03	3.5E-07	N/A	N/A
1,4-Dichlorobenzene	1.3E+00	1.2E+04	6.2E-06	1.6E-03	9.8E-09	6.9E-03	6.7E-11
2-Butanone	1.0E+01	1.3E+04	4.9E-05	1.6E-03	7.7E-08	N/A	N/A
4-Methyl-2-pentanone	8.4E+00	9.9E+03	5.1E-05	1.6E-03	8.1E-08	N/A	N/A
Acetone	8.7E+00	1.2E+04	4.4E-05	1.6E-03	7.0E-08	N/A	N/A
Benzene	8.9E-01	2.6E+03	2.1E-05	1.6E-03	3.3E-08	7.8E-03	2.6E-10
Carbon disulfide	1.5E+00	1.1E+03	7.9E-05	1.6E-03	1.3E-07	N/A	N/A
Chlorobenzene	1.8E+00	5.9E+03	1.8E-05	1.6E-03	2.9E-08	N/A	N/A
Ethylbenzene	6.2E+01	5.1E+03	7.3E-04	1.6E-03	1.2E-06	N/A	N/A
Isopropylbenzene	1.9E+00	1.0E+03	1.1E-04	1.6E-03	1.8E-07	N/A	N/A
n-Butylbenzene	1.0E+01	7.7E+03	7.8E-05	1.6E-03	1.2E-07	N/A	N/A
n-Propylbenzene	4.1E+00	6.0E+03	4.1E-05	1.6E-03	6.5E-08	N/A	N/A
Naphthalene	9.5E+00	5.2E+04	1.1E-05	1.6E-03	1.7E-08	N/A	N/A
Methyl tert butyl ether	1.1E+00	3.9E+03	1.6E-05	1.6E-03	2.6E-08	N/A	N/A
Methylene chloride	5.1E+00	2.3E+03	1.3E-04	1.6E-03	2.1E-07	1.0E-05	2.1E-12
o-Xylene	1.1E+01	5.8E+03	1.1E-04	1.6E-03	1.8E-07	N/A	N/A
p-Isopropyltoluene	1.7E+00	1.0E+03	9.7E-05	1.6E-03	1.5E-07	N/A	N/A
p/m-Xylene	6.2E+01	5.2E+03	7.1E-04	1.6E-03	1.1E-06	N/A	N/A
sec-Butylbenzene	1.2E+00	7.0E+03	1.0E-05	1.6E-03	1.6E-08	N/A	N/A
Styrene	5.6E+00	1.3E+04	2.7E-05	1.6E-03	4.2E-08	5.7E-04	2.4E-11
Toluene	1.9E+00	3.7E+03	3.1E-05	1.6E-03	5.0E-08	N/A	N/A
Total Xylenes	1.2E+02	5.2E+03	1.4E-03	1.6E-03	2.2E-06	N/A	N/A
Cancer Risk							3E-10

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.06	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	8	(hours/day)
Exposure Frequency (EF)	130	(days/year)
Exposure Duration (ED)	1	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil / VF

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADD_{inhal} =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

VF = Volatilization Factor

Table C-5-1
Future Land Use Scenario - Recreational Adult
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	2.2E-08	2.5E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	2.2E-08	1.0E-07	1.0E-02	1.0E-05
2-Butanone	1.6E-02	1.0E+00	2.2E-08	3.6E-10	6.0E-01	5.9E-10
Acetone	9.2E-01	1.0E+00	2.2E-08	2.0E-08	9.0E-01	2.3E-08
Benzene	1.6E-03	1.0E+00	2.2E-08	3.6E-11	4.0E-03	8.9E-09
Ethylbenzene	9.2E-01	1.0E+00	2.2E-08	2.0E-08	1.0E-01	2.0E-07
Isopropylbenzene	1.1E-01	9.9E-01	2.2E-08	2.4E-09	1.0E-01	2.4E-08
n-Butylbenzene	1.4E+00	9.9E-01	2.2E-08	3.1E-08	5.0E-02	6.2E-07
n-Propylbenzene	3.7E-01	9.9E-01	2.2E-08	8.3E-09	1.0E-01	8.3E-08
Naphthalene	1.1E+00	3.6E-01	8.0E-09	8.9E-09	2.0E-02	4.5E-07
Methyl tert butyl ether	1.9E-01	1.0E+00	2.2E-08	4.2E-09	1.0E-01	4.2E-08
Methylene chloride	7.1E-01	1.0E+00	2.2E-08	1.6E-08	6.0E-03	2.6E-06
o-Xylene	1.4E+00	1.0E+00	2.2E-08	3.0E-08	2.0E-01	1.5E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	2.2E-08	2.3E-09	1.0E-01	2.3E-08
p/m-Xylene	6.7E+00	1.0E+00	2.2E-08	1.5E-07	2.0E-01	7.5E-07
Toluene	5.7E-02	1.0E+00	2.2E-08	1.3E-09	8.0E-02	1.6E-08
Total Xylenes	1.2E+00	1.0E+00	2.2E-08	2.7E-08	2.0E-01	1.4E-07
2,4-Dimethylphenol	2.0E+00	1.0E+00	2.2E-08	4.5E-08	2.0E-02	2.3E-06
3-Methylphenol/4-Methylphenol	9.2E-01	9.1E-01	2.0E-08	1.9E-08	5.0E-02	3.7E-07
Phenol	1.0E+00	1.0E+00	2.2E-08	2.3E-08	3.0E-01	7.7E-08
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	2.2E-08	5.9E-09	2.0E-02	2.9E-07
Barium	2.6E+01	1.0E+00	2.2E-08	5.8E-07	2.0E-01	2.9E-06
Cadmium	3.1E+01	1.0E+00	2.2E-08	7.0E-07	1.0E-03	7.0E-04
Copper	2.2E+01	3.9E-01	8.7E-09	1.9E-07	4.0E-02	4.9E-06
Iron	1.0E+04	3.9E-01	8.7E-09	9.0E-05	7.0E-01	1.3E-04
Lead	7.2E+01	5.0E-01	1.1E-08	8.0E-07	7.5E-04	1.1E-03
Silver	2.9E-01	1.0E+00	2.2E-08	6.4E-09	5.0E-03	1.3E-06
Zinc	2.1E+03	1.0E+00	2.2E-08	4.7E-05	3.0E-01	1.6E-04
2-Methylphenol	9.8E-01	9.9E-01	2.2E-08	2.2E-08	5.0E-02	4.3E-07
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	9.9E-01	2.2E-08	8.8E-08	8.0E-05	1.1E-03
Chloromethane	9.8E-03	9.9E-01	2.2E-08	2.2E-10	N/A	N/A
Trichlorofluoromethane	3.6E-03	9.9E-01	2.2E-08	7.9E-11	3.0E-01	2.6E-10
Hazard Index						3E-03

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-5-2
Future Land Use Scenario - Recreational Adult
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	1.0E+00	8.9E-09	1.4E-11	5.5E-02	7.8E-13
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	8.9E-09	6.3E-09	2.0E-03	1.3E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	8.9E-09	2.4E-09	1.4E-02	3.3E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						5E-11

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-5-3
Future Land Use Scenario - Recreational Adult
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	2.0E-08	2.2E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	2.0E-08	9.2E-08	1.0E-02	9.2E-06
2-Butanone	1.6E-02	1.0E-01	1.8E-08	2.9E-10	6.0E-01	4.8E-10
Acetone	9.2E-01	1.0E-01	1.8E-08	1.7E-08	9.0E-01	1.8E-08
Benzene	1.6E-03	8.0E-02	1.4E-08	2.3E-11	4.0E-03	5.8E-09
Ethylbenzene	9.2E-01	2.0E-01	3.6E-08	3.3E-08	1.0E-01	3.3E-07
Isopropylbenzene	1.1E-01	1.1E-01	2.0E-08	2.1E-09	1.0E-01	2.1E-08
n-Butylbenzene	1.4E+00	1.1E-01	2.0E-08	2.8E-08	5.0E-02	5.5E-07
n-Propylbenzene	3.7E-01	1.1E-01	2.0E-08	7.4E-09	1.0E-01	7.4E-08
Naphthalene	1.1E+00	1.0E-01	1.8E-08	2.0E-08	2.0E-02	1.0E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	1.8E-08	3.4E-09	1.0E-01	3.4E-08
Methylene chloride	7.1E-01	1.0E-01	1.8E-08	1.3E-08	6.0E-03	2.1E-06
o-Xylene	1.4E+00	1.2E-01	2.2E-08	2.9E-08	2.0E-01	1.5E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	2.0E-08	2.1E-09	1.0E-01	2.1E-08
p/m-Xylene	6.7E+00	1.2E-01	2.2E-08	1.5E-07	2.0E-01	7.3E-07
Toluene	5.7E-02	1.2E-01	2.2E-08	1.2E-09	8.0E-02	1.5E-08
Total Xylenes	1.2E+00	1.2E-01	2.2E-08	2.6E-08	2.0E-01	1.3E-07
2,4-Dimethylphenol	2.0E+00	2.6E-01	4.7E-08	9.5E-08	2.0E-02	4.8E-06
3-Methylphenol/4-Methylphenol	9.2E-01	1.7E-01	3.1E-08	2.8E-08	5.0E-02	5.6E-07
Phenol	1.0E+00	2.6E-01	4.7E-08	4.9E-08	3.0E-01	1.6E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	3.6E-09	9.5E-10	2.0E-02	4.8E-08
Barium	2.6E+01	5.0E-02	9.0E-09	2.3E-07	2.0E-01	1.2E-06
Cadmium	3.1E+01	1.4E-01	2.5E-08	7.9E-07	1.0E-03	7.9E-04
Copper	2.2E+01	3.0E-02	5.4E-09	1.2E-07	4.0E-02	3.0E-06
Iron	1.0E+04	3.0E-02	5.4E-09	5.6E-05	7.0E-01	8.0E-05
Lead	7.2E+01	6.0E-03	1.1E-09	7.7E-08	7.5E-04	1.0E-04
Silver	2.9E-01	2.5E-01	4.5E-08	1.3E-08	5.0E-03	2.6E-06
Zinc	2.1E+03	2.0E-02	3.6E-09	7.7E-06	3.0E-01	2.6E-05
2-Methylphenol	9.8E-01	1.1E-01	2.0E-08	2.0E-08	5.0E-02	3.9E-07
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	1.1E-01	2.0E-08	7.9E-08	8.0E-05	9.9E-04
Chloromethane	9.8E-03	1.1E-01	2.0E-08	1.9E-10	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.1E-01	2.0E-08	7.1E-11	3.0E-01	2.4E-10
Hazard Index						2E-03

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	10,950	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-5-4
Future Land Use Scenario - Recreational Adult
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	8.0E-02	5.8E-09	9.2E-12	5.5E-02	5.1E-13
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	7.2E-09	5.1E-09	2.0E-03	1.0E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	1.4E-09	3.8E-10	1.4E-02	5.3E-12
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						2E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	5781	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.07	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Body Weight (BW)	70	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-5-5
Future Land Use Scenario - Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	3.1E-02	2.6E-06	7.0E-03	3.7E-04
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	3.1E-02	2.5E-06	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	3.1E-02	2.4E-06	5.0E+00	4.9E-07
Acetone	9.2E-01	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
Benzene	1.6E-03	2.6E+03	3.9E-04	3.1E-02	1.2E-05	3.0E-02	4.1E-04
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	3.1E-02	6.2E-06	1.0E+00	6.2E-06
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	3.1E-02	4.0E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	3.1E-02	5.2E-06	1.0E+00	5.2E-06
Naphthalene	1.1E+00	5.2E+04	1.9E-05	3.1E-02	6.0E-07	3.0E-03	2.0E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	3.1E-02	8.0E-06	3.0E+00	2.7E-06
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	3.1E-02	1.3E-05	6.0E-01	2.2E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	3.1E-02	5.4E-06	1.0E-01	5.4E-05
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
Toluene	5.7E-02	3.7E+03	2.7E-04	3.1E-02	8.3E-06	5.0E+00	1.7E-06
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	3.1E-02	2.0E-09	7.0E-02	2.9E-08
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	3.1E-02	9.2E-10	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	3.1E-02	1.0E-09	2.6E-01	4.0E-09
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	3.1E-02	2.6E-10	7.0E-03	3.8E-08
Barium	2.6E+01	N/A	8.3E-07	3.1E-02	2.6E-08	5.0E-04	5.2E-05
Cadmium	3.1E+01	N/A	1.0E-06	3.1E-02	3.1E-08	2.0E-05	1.6E-03
Copper	2.2E+01	N/A	7.2E-07	3.1E-02	2.2E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	3.1E-02	1.0E-05	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	3.1E-02	7.1E-08	1.0E-03	7.1E-05
Silver	2.9E-01	N/A	9.2E-09	3.1E-02	2.9E-10	1.4E-04	2.0E-06
Zinc	2.1E+03	N/A	6.8E-05	3.1E-02	2.1E-06	1.4E-03	1.5E-03
2-Methylphenol	9.8E-01	N/A	3.1E-08	3.1E-02	9.8E-10	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	3.1E-02	4.0E-09	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	3.1E-02	3.0E-05	9.0E-02	3.4E-04
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	3.1E-02	1.8E-05	7.0E-01	2.6E-05
Hazard Index							5E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	10,950	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table C-5-6
Future Land Use Scenario - Recreational Adult
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk (mg/m^3)$^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	1.2E-02	1.0E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	1.2E-02	1.0E-06	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	1.2E-02	9.8E-07	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	1.2E-02	1.1E-06	N/A	N/A
Benzene	1.6E-03	2.6E+03	3.9E-04	1.2E-02	4.9E-06	7.8E-03	3.8E-08
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	1.2E-02	2.5E-06	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	1.2E-02	1.2E-05	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	1.2E-02	1.6E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	1.2E-02	2.1E-06	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	1.2E-02	2.4E-07	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	1.2E-02	3.2E-06	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	1.2E-02	5.3E-06	1.0E-05	5.3E-11
o-Xylene	1.4E+00	5.8E+03	1.7E-04	1.2E-02	2.2E-06	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	1.2E-02	1.2E-05	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	1.2E-02	2.4E-06	N/A	N/A
Toluene	5.7E-02	3.7E+03	2.7E-04	1.2E-02	3.3E-06	N/A	N/A
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	1.2E-02	2.4E-06	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	1.2E-02	8.1E-10	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	1.2E-02	3.7E-10	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	1.2E-02	4.2E-10	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	1.2E-02	1.1E-10	1.3E-03	1.4E-13
Barium	2.6E+01	N/A	8.3E-07	1.2E-02	1.0E-08	N/A	N/A
Cadmium	3.1E+01	N/A	1.0E-06	1.2E-02	1.3E-08	1.8E+00	2.3E-08
Copper	2.2E+01	N/A	7.2E-07	1.2E-02	9.0E-09	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	1.2E-02	4.1E-06	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	1.2E-02	2.9E-08	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	1.2E-02	1.1E-10	N/A	N/A
Zinc	2.1E+03	N/A	6.8E-05	1.2E-02	8.5E-07	N/A	N/A
2-Methylphenol	9.8E-01	N/A	3.1E-08	1.2E-02	3.9E-10	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	1.2E-02	1.6E-09	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	1.2E-02	1.2E-05	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	1.2E-02	7.3E-06	N/A	N/A
Cancer Risk							6E-08

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	30	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

VF = Volatilization Factor

Table C-6-1
Future Land Use Scenario - Recreational Youth
Incidental Soil Ingestion: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	9.9E-01	3.6E-08	4.0E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	9.9E-01	3.6E-08	1.7E-07	1.0E-02	1.7E-05
2-Butanone	1.6E-02	1.0E+00	3.6E-08	5.8E-10	6.0E-01	9.7E-10
Acetone	9.2E-01	1.0E+00	3.6E-08	3.3E-08	9.0E-01	3.7E-08
Benzene	1.6E-03	1.0E+00	3.6E-08	5.8E-11	4.0E-03	1.4E-08
Ethylbenzene	9.2E-01	1.0E+00	3.6E-08	3.3E-08	1.0E-01	3.3E-07
Isopropylbenzene	1.1E-01	9.9E-01	3.6E-08	3.9E-09	1.0E-01	3.9E-08
n-Butylbenzene	1.4E+00	9.9E-01	3.6E-08	5.0E-08	5.0E-02	1.0E-06
n-Propylbenzene	3.7E-01	9.9E-01	3.6E-08	1.3E-08	1.0E-01	1.3E-07
Naphthalene	1.1E+00	3.6E-01	1.3E-08	1.5E-08	2.0E-02	7.3E-07
Methyl tert butyl ether	1.9E-01	1.0E+00	3.6E-08	6.8E-09	1.0E-01	6.8E-08
Methylene chloride	7.1E-01	1.0E+00	3.6E-08	2.6E-08	6.0E-03	4.3E-06
o-Xylene	1.4E+00	1.0E+00	3.6E-08	4.9E-08	2.0E-01	2.5E-07
p-Isopropyltoluene	1.0E-01	9.9E-01	3.6E-08	3.8E-09	1.0E-01	3.8E-08
p/m-Xylene	6.7E+00	1.0E+00	3.6E-08	2.4E-07	2.0E-01	1.2E-06
Toluene	5.7E-02	1.0E+00	3.6E-08	2.1E-09	8.0E-02	2.6E-08
Total Xylenes	1.2E+00	1.0E+00	3.6E-08	4.4E-08	2.0E-01	2.2E-07
2,4-Dimethylphenol	2.0E+00	1.0E+00	3.6E-08	7.4E-08	2.0E-02	3.7E-06
3-Methylphenol/4-Methylphenol	9.2E-01	9.1E-01	3.3E-08	3.0E-08	5.0E-02	6.1E-07
Phenol	1.0E+00	1.0E+00	3.6E-08	3.8E-08	3.0E-01	1.3E-07
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	3.6E-08	9.6E-09	2.0E-02	4.8E-07
Barium	2.6E+01	1.0E+00	3.6E-08	9.4E-07	2.0E-01	4.7E-06
Cadmium	3.1E+01	1.0E+00	3.6E-08	1.1E-06	1.0E-03	1.1E-03
Copper	2.2E+01	3.9E-01	1.4E-08	3.2E-07	4.0E-02	7.9E-06
Iron	1.0E+04	3.9E-01	1.4E-08	1.5E-04	7.0E-01	2.1E-04
Lead	7.2E+01	5.0E-01	1.8E-08	1.3E-06	7.5E-04	1.7E-03
Silver	2.9E-01	1.0E+00	3.6E-08	1.0E-08	5.0E-03	2.1E-06
Zinc	2.1E+03	1.0E+00	3.6E-08	7.7E-05	3.0E-01	2.6E-04
2-Methylphenol	9.8E-01	9.9E-01	3.6E-08	3.5E-08	5.0E-02	7.1E-07
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	9.9E-01	3.6E-08	1.4E-07	8.0E-05	1.8E-03
Chloromethane	9.8E-03	9.9E-01	3.6E-08	3.5E-10	N/A	N/A
Trichlorofluoromethane	3.6E-03	9.9E-01	3.6E-08	1.3E-10	3.0E-01	4.3E-10
Hazard Index						5E-03

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-6-2
Future Land Use Scenario - Recreational Youth
Incidental Soil Ingestion: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-d)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	1.0E+00	5.3E-09	8.5E-12	5.5E-02	4.7E-13
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E+00	5.3E-09	3.8E-09	2.0E-03	7.6E-12
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	1.0E+00	5.3E-09	1.4E-09	1.4E-02	2.0E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						3E-11

EXPOSURE ASSUMPTIONS

Soil Ingestion Rate (IR)	50	(mg/day)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(IR * CF1 * CF2 * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK

Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)

Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-6-3
Future Land Use Scenario - Recreational Youth
Soil Dermal Contact: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	RfD oral (mg/kg-day)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.1E-01	1.3E-07	1.4E-06	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.1E-01	1.3E-07	6.0E-07	1.0E-02	6.0E-05
2-Butanone	1.6E-02	1.0E-01	1.2E-07	1.9E-09	6.0E-01	3.1E-09
Acetone	9.2E-01	1.0E-01	1.2E-07	1.1E-07	9.0E-01	1.2E-07
Benzene	1.6E-03	8.0E-02	9.3E-08	1.5E-10	4.0E-03	3.7E-08
Ethylbenzene	9.2E-01	2.0E-01	2.3E-07	2.1E-07	1.0E-01	2.1E-06
Isopropylbenzene	1.1E-01	1.1E-01	1.3E-07	1.4E-08	1.0E-01	1.4E-07
n-Butylbenzene	1.4E+00	1.1E-01	1.3E-07	1.8E-07	5.0E-02	3.6E-06
n-Propylbenzene	3.7E-01	1.1E-01	1.3E-07	4.8E-08	1.0E-01	4.8E-07
Naphthalene	1.1E+00	1.0E-01	1.2E-07	1.3E-07	2.0E-02	6.5E-06
Methyl tert butyl ether	1.9E-01	1.0E-01	1.2E-07	2.2E-08	1.0E-01	2.2E-07
Methylene chloride	7.1E-01	1.0E-01	1.2E-07	8.3E-08	6.0E-03	1.4E-05
o-Xylene	1.4E+00	1.2E-01	1.4E-07	1.9E-07	2.0E-01	9.5E-07
p-Isopropyltoluene	1.0E-01	1.1E-01	1.3E-07	1.3E-08	1.0E-01	1.3E-07
p/m-Xylene	6.7E+00	1.2E-01	1.4E-07	9.4E-07	2.0E-01	4.7E-06
Toluene	5.7E-02	1.2E-01	1.4E-07	8.0E-09	8.0E-02	1.0E-07
Total Xylenes	1.2E+00	1.2E-01	1.4E-07	1.7E-07	2.0E-01	8.5E-07
2,4-Dimethylphenol	2.0E+00	2.6E-01	3.0E-07	6.2E-07	2.0E-02	3.1E-05
3-Methylphenol/4-Methylphenol	9.2E-01	1.7E-01	2.0E-07	1.8E-07	5.0E-02	3.6E-06
Phenol	1.0E+00	2.6E-01	3.0E-07	3.2E-07	3.0E-01	1.1E-06
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	2.3E-08	6.2E-09	2.0E-02	3.1E-07
Barium	2.6E+01	5.0E-02	5.8E-08	1.5E-06	2.0E-01	7.5E-06
Cadmium	3.1E+01	1.4E-01	1.6E-07	5.1E-06	1.0E-03	5.1E-03
Copper	2.2E+01	3.0E-02	3.5E-08	7.9E-07	4.0E-02	2.0E-05
Iron	1.0E+04	3.0E-02	3.5E-08	3.6E-04	7.0E-01	5.2E-04
Lead	7.2E+01	6.0E-03	7.0E-09	5.0E-07	7.5E-04	6.7E-04
Silver	2.9E-01	2.5E-01	2.9E-07	8.4E-08	5.0E-03	1.7E-05
Zinc	2.1E+03	2.0E-02	2.3E-08	5.0E-05	3.0E-01	1.7E-04
2-Methylphenol	9.8E-01	1.1E-01	1.3E-07	1.3E-07	5.0E-02	2.5E-06
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	1.1E-01	1.3E-07	5.1E-07	8.0E-05	6.4E-03
Chloromethane	9.8E-03	1.1E-01	1.3E-07	1.3E-09	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.1E-01	1.3E-07	4.6E-10	3.0E-01	1.5E-09
Hazard Index						1E-02

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	4,015	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)

ADD = (Conc. * Exposure Factor)

Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR HAZARD QUOTIENT (HQ)

Hazard Quotient (HQ) = ADD / RfD

Hazard Index (HI) = Sum of HQs

RfD = Reference Dose

Table C-6-4
Future Land Use Scenario - Recreational Youth
Soil Dermal Contact: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	RAF (unitless)	Exposure Factor (kg/kg-day)	ADD (mg/kg-day)	SF oral (mg/kg-day)-1	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	N/A	N/A	N/A	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	N/A	N/A	N/A	N/A	N/A
2-Butanone	1.6E-02	N/A	N/A	N/A	N/A	N/A
Acetone	9.2E-01	N/A	N/A	N/A	N/A	N/A
Benzene	1.6E-03	8.0E-02	1.4E-08	2.2E-11	5.5E-02	1.2E-12
Ethylbenzene	9.2E-01	N/A	N/A	N/A	N/A	N/A
Isopropylbenzene	1.1E-01	N/A	N/A	N/A	N/A	N/A
n-Butylbenzene	1.4E+00	N/A	N/A	N/A	N/A	N/A
n-Propylbenzene	3.7E-01	N/A	N/A	N/A	N/A	N/A
Naphthalene	1.1E+00	N/A	N/A	N/A	N/A	N/A
Methyl tert butyl ether	1.9E-01	N/A	N/A	N/A	N/A	N/A
Methylene chloride	7.1E-01	1.0E-01	1.7E-08	1.2E-08	2.0E-03	2.4E-11
o-Xylene	1.4E+00	N/A	N/A	N/A	N/A	N/A
p-Isopropyltoluene	1.0E-01	N/A	N/A	N/A	N/A	N/A
p/m-Xylene	6.7E+00	N/A	N/A	N/A	N/A	N/A
Toluene	5.7E-02	N/A	N/A	N/A	N/A	N/A
Total Xylenes	1.2E+00	N/A	N/A	N/A	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	N/A	N/A	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	N/A	N/A	N/A	N/A
Phenol	1.0E+00	N/A	N/A	N/A	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	2.0E-02	3.4E-09	9.0E-10	1.4E-02	1.3E-11
Barium	2.6E+01	N/A	N/A	N/A	N/A	N/A
Cadmium	3.1E+01	N/A	N/A	N/A	N/A	N/A
Copper	2.2E+01	N/A	N/A	N/A	N/A	N/A
Iron	1.0E+04	N/A	N/A	N/A	N/A	N/A
Lead	7.2E+01	N/A	N/A	N/A	N/A	N/A
Silver	2.9E-01	N/A	N/A	N/A	N/A	N/A
Zinc	2.1E+03	N/A	N/A	N/A	N/A	N/A
2-Methylphenol	9.8E-01	N/A	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	N/A	N/A	N/A	N/A
Chloromethane	9.8E-03	N/A	N/A	N/A	N/A	N/A
Trichlorofluoromethane	3.6E-03	N/A	N/A	N/A	N/A	N/A
Cancer Risk						4E-11

EXPOSURE ASSUMPTIONS

Skin Surface Area (SA)	4600	(cm^2)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Soil Adherence Factor (AF)	0.35	(mg/cm^2-day)
Relative Absorption Factor (RAF)	chemical-specific	(unitless)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Body Weight (BW)	43	(kg)
Averaging Time (AT)	27,375	(days)

EQUATION FOR AVERAGE DAILY DOSE (ADD)
ADD = (Conc. * Exposure Factor)
Exposure Factor = [(SA * CF1 * CF2 * AF * RAF * ET * EF * ED) / (BW * AT)]

EQUATION FOR CANCER RISK
Incremental Cancer Risk = ADD * Cancer Slope Factor (oral)
Cancer Risk = Sum of Incremental Cancer Risks

SF = Slope Factor

Table C-6-5
Future Land Use Scenario - Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Soil: Hazard Index
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	RfC (mg/m^3)	Hazard Quotient
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	3.1E-02	2.6E-06	7.0E-03	3.7E-04
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	3.1E-02	2.5E-06	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	3.1E-02	2.4E-06	5.0E+00	4.9E-07
Acetone	9.2E-01	1.2E+04	8.5E-05	3.1E-02	2.6E-06	8.0E-01	3.3E-06
Benzene	1.6E-03	2.6E+03	3.9E-04	3.1E-02	1.2E-05	3.0E-02	4.1E-04
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	3.1E-02	6.2E-06	1.0E+00	6.2E-06
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	3.1E-02	4.0E-06	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	3.1E-02	5.2E-06	1.0E+00	5.2E-06
Naphthalene	1.1E+00	5.2E+04	1.9E-05	3.1E-02	6.0E-07	3.0E-03	2.0E-04
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	3.1E-02	8.0E-06	3.0E+00	2.7E-06
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	3.1E-02	1.3E-05	6.0E-01	2.2E-05
o-Xylene	1.4E+00	5.8E+03	1.7E-04	3.1E-02	5.4E-06	1.0E-01	5.4E-05
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	3.1E-02	3.1E-05	4.0E-01	7.7E-05
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
Toluene	5.7E-02	3.7E+03	2.7E-04	3.1E-02	8.3E-06	5.0E+00	1.7E-06
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	3.1E-02	6.0E-06	1.0E-01	6.0E-05
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	3.1E-02	2.0E-09	7.0E-02	2.9E-08
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	3.1E-02	9.2E-10	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	3.1E-02	1.0E-09	2.6E-01	4.0E-09
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	3.1E-02	2.6E-10	7.0E-03	3.8E-08
Barium	2.6E+01	N/A	8.3E-07	3.1E-02	2.6E-08	5.0E-04	5.2E-05
Cadmium	3.1E+01	N/A	1.0E-06	3.1E-02	3.1E-08	2.0E-05	1.6E-03
Copper	2.2E+01	N/A	7.2E-07	3.1E-02	2.2E-08	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	3.1E-02	1.0E-05	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	3.1E-02	7.1E-08	1.0E-03	7.1E-05
Silver	2.9E-01	N/A	9.2E-09	3.1E-02	2.9E-10	1.4E-04	2.0E-06
Zinc	2.1E+03	N/A	6.8E-05	3.1E-02	2.1E-06	1.4E-03	1.5E-03
2-Methylphenol	9.8E-01	N/A	3.1E-08	3.1E-02	9.8E-10	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	3.1E-02	4.0E-09	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	3.1E-02	3.0E-05	9.0E-02	3.4E-04
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	3.1E-02	1.8E-05	7.0E-01	2.6E-05
Hazard Index							5E-03

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	4,015	(days)

EQUATION FOR CONCENTRATION IN AIR
Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)
ADE =(Conc. in Air * Exposure Factor)
Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR HAZARD QUOTIENT (HQ)
Hazard Quotient (HQ) = ADE / RfC

Hazard Index (HI) = Sum of HQs
RfC = Reference Concentration
VF = Volatilization Factor

Table C-6-6
Future Land Use Scenario - Recreational Youth
Inhalation of Airborne Particulates and Volatiles from Soil: Cancer Risk
Reichhold, Inc., Andover, Massachusetts

Parameter	Average Conc. (mg/kg (ppm))	VF (m^3/kg)	Conc. in Air (mg/m^3)	Exposure Factor (unitless)	ADE (mg/m^3)	Unit Risk $(mg/m^3)^{-1}$	Cancer Risk
1,2,4-Trimethylbenzene	1.1E+01	1.2E+04	8.4E-05	4.6E-03	3.8E-07	N/A	N/A
1,3,5-Trimethylbenzene	4.7E+00	1.2E+04	8.1E-05	4.6E-03	3.7E-07	N/A	N/A
2-Butanone	1.6E-02	1.3E+04	7.8E-05	4.6E-03	3.6E-07	N/A	N/A
Acetone	9.2E-01	1.2E+04	8.5E-05	4.6E-03	3.9E-07	N/A	N/A
Benzene	1.6E-03	2.6E+03	3.9E-04	4.6E-03	1.8E-06	7.8E-03	1.4E-08
Ethylbenzene	9.2E-01	5.1E+03	2.0E-04	4.6E-03	9.0E-07	N/A	N/A
Isopropylbenzene	1.1E-01	1.0E+03	9.8E-04	4.6E-03	4.5E-06	N/A	N/A
n-Butylbenzene	1.4E+00	7.7E+03	1.3E-04	4.6E-03	5.9E-07	N/A	N/A
n-Propylbenzene	3.7E-01	6.0E+03	1.7E-04	4.6E-03	7.6E-07	N/A	N/A
Naphthalene	1.1E+00	5.2E+04	1.9E-05	4.6E-03	8.7E-08	N/A	N/A
Methyl tert butyl ether	1.9E-01	3.9E+03	2.6E-04	4.6E-03	1.2E-06	N/A	N/A
Methylene chloride	7.1E-01	2.3E+03	4.3E-04	4.6E-03	2.0E-06	1.0E-05	2.0E-11
o-Xylene	1.4E+00	5.8E+03	1.7E-04	4.6E-03	7.9E-07	N/A	N/A
p-Isopropyltoluene	1.0E-01	1.0E+03	9.8E-04	4.6E-03	4.5E-06	N/A	N/A
p/m-Xylene	6.7E+00	5.2E+03	1.9E-04	4.6E-03	8.7E-07	N/A	N/A
Toluene	5.7E-02	3.7E+03	2.7E-04	4.6E-03	1.2E-06	N/A	N/A
Total Xylenes	1.2E+00	5.2E+03	1.9E-04	4.6E-03	8.7E-07	N/A	N/A
2,4-Dimethylphenol	2.0E+00	N/A	6.5E-08	4.6E-03	3.0E-10	N/A	N/A
3-Methylphenol/4-Methylphenol	9.2E-01	N/A	2.9E-08	4.6E-03	1.3E-10	N/A	N/A
Phenol	1.0E+00	N/A	3.3E-08	4.6E-03	1.5E-10	N/A	N/A
bis(2-Ethylhexyl)phthalate	2.6E-01	N/A	8.4E-09	4.6E-03	3.9E-11	1.3E-03	5.0E-14
Barium	2.6E+01	N/A	8.3E-07	4.6E-03	3.8E-09	N/A	N/A
Cadmium	3.1E+01	N/A	1.0E-06	4.6E-03	4.6E-09	1.8E+00	8.3E-09
Copper	2.2E+01	N/A	7.2E-07	4.6E-03	3.3E-09	N/A	N/A
Iron	1.0E+04	N/A	3.3E-04	4.6E-03	1.5E-06	N/A	N/A
Lead	7.2E+01	N/A	2.3E-06	4.6E-03	1.0E-08	N/A	N/A
Silver	2.9E-01	N/A	9.2E-09	4.6E-03	4.2E-11	N/A	N/A
Zinc	2.1E+03	N/A	6.8E-05	4.6E-03	3.1E-07	N/A	N/A
2-Methylphenol	9.8E-01	N/A	3.1E-08	4.6E-03	1.4E-10	N/A	N/A
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	4.0E+00	N/A	1.3E-07	4.6E-03	5.8E-10	N/A	N/A
Chloromethane	9.8E-03	1.0E+03	9.7E-04	4.6E-03	4.4E-06	N/A	N/A
Trichlorofluoromethane	3.6E-03	1.7E+03	5.8E-04	4.6E-03	2.7E-06	N/A	N/A
Cancer Risk							2E-08

EXPOSURE ASSUMPTIONS

Airborne Particulate Concentration (PA)	0.032	(mg/m^3)
Conversion Factor 1 (CF1)	1.0E-06	(kg/mg)
Conversion Factor 2 (CF2)	0.042	(day/hour)
Exposure Time (ET)	3	(hours/day)
Exposure Frequency (EF)	91	(days/year)
Exposure Duration (ED)	11	(years)
Averaging Time (AT)	27,375	(days)

EQUATION FOR CONCENTRATION IN AIR

Conc. in Air = Conc. in Soil * [PA * CF1 + 1 / (VF)]

EQUATION FOR AVERAGE DAILY EXPOSURE (ADE)

ADE =(Conc. in Air * Exposure Factor)

Exposure Factor = [(ET * EF * ED * CF2) / AT]

EQUATION FOR RISK

Incremental Cancer Risk = ADE * Unit Risk

Cancer Risk = Sum of Incremental Cancer Risks

VF = Volatilization Factor

Attachment D – Notice of Activity and Use Limitation - Parcel I Former Manufacturing Area

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC113

ACTIVITY & USE LIMITATION (AUL) TRANSMITTAL FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

Release Tracking Number: 3 - 208

A. DISPOSAL SITE LOCATION:

1. Disposal Site Name: **REICHHOLD CHEMICALS INC FMR**

2. Street Address: **77 LOWELL JUNCTION RD**

3. City/Town: **ANDOVER** 4. ZIP Code: **05544-0000**

☑ 5. Check here if a Tier Classification Submittal has been provided to DEP for this disposal site.

☐ a. Tier 1A ☐ b. Tier 1B ☐ c. Tier 1C ☑ d. Tier 2

6. If a Tier I Permit has been issued, provide Permit Number:

B. THIS FORM IS BEING USED TO: (check one)

☑ 1. Submit a certified copy of a **Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1074.

☐ 2. Submit an **Evaluation of Changes in Land Uses/Activities and/or Site Conditions after a Response Action Outcome Statement** has been filed pursuant to 310 CMR 40.1080.

☐ 3. Submit a certified copy of an **Amended Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1081

☐ 4. Submit a certified copy of a **Partial Termination of a Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1083(3).

☐ 5. Submit a certified copy of a **Termination of a Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1083(1)(d).

☐ 6. Submit a certified copy of a **Grant of Environmental Restriction**, pursuant to 310 CMR 40.1071.

☐ 7. Submit a certified copy of an **Amendment of a Grant of Environmental Restriction**, pursuant to 310 CMR 40.1081(3).

☐ 8. Submit a certified copy of a **Partial Release of a Grant of Environmental Restriction**, pursuant to 310 CMR 40.1083(2).

☐ 9. Submit a certified copy of a **Release of a Grant of Environmental Restriction,** pursuant to 310 CMR 40.1083(1)(c).

☐ 10. Submit a certified copy of a **Confirmatory Activity and Use Limitation,** pursuant to 310 CMR 40.1085(4).

11. Provide Additional RTNs:

☐ a. Check here if this AUL Submittal covers additional Release Tracking Numbers (RTNs).

b. Provide the additional Release Tracking Number(s) covered by this AUL Submittal. ___ - ___ ___ - ___

(All sections of this transmittal form must be filled out unless otherwise noted above. BWSC113A is required for all submittals listed above)

ACTIVITY & USE LIMITATION (AUL) TRANSMITTAL FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

Release Tracking Number: 3 - 208

C. AUL INFORMATION:

1. Document (per Section B) Recording and/or Registration Information:
   a. Name of Registry of Deeds and/or Land Registration Office: **ESSEX COUNTY - NORTHERN DISTRICT**
   b. Book and Page Number and/or Document Number: **BOOK 13333 PAGE 27**
   c. Date of recording and/or registration: **2/4/2013** mm/dd/yyyy
2. Is the address of the property subject to AUL different from the disposal site address listed above?
   ☑ a. No ☐ b. Yes If yes, then fill out address section below.
3. Street Address: ______
4. City/Town: ______ 5. ZIP Code: ______

D. PERSON SUBMITTING AUL TRANSMITTAL FORM:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☐ c. change in the person undertaking response actions
2. Name of Organization: **REICHHOLD INC**
3. Contact First Name: **JOHN** 4. Last Name: **OLDHAM**
5. Street: **PO BOX 13582** 6. Title: **PROJECT MGR**
7. City/Town: **RESEARCH TRIANGLE PARK** 8. State: **NC** 9. ZIP Code: **27709-3582**
10. Telephone: **(919) 990-7789** 11. Ext.: ______ 12. FAX: ______
13. Is the person described in this section the owner of the property?
    ☑ a. Yes ☐ b. No , if checked then Section G must be filled out by at least one owner.
    ☐ c. Check here if providing names and addresses of any additional owners in an attachment.

E. RELATIONSHIP TO DISPOSAL SITE OF PERSON SUBMITTING AUL TRANSMITTAL FORM: (check one)

☑ 1. RP or PRP ☑ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter
☐ e. Other RP or PRP Specify: ______

☐ 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ 4. Any Other Person Submitting AUL Specify: ______

ACTIVITY & USE LIMITATION (AUL) TRANSMITTAL FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

Release Tracking Number: 3 - 208

F. REOUIRED ATTACHMENT AND SUBMITTALS:

☑ 1. Check here to certify that notice of the proposed Activity and Use Limitation (AUL) was given to all record-interest holders, if any, in accordance with 310 CMR 40.1074(1)(e), via certified mail.

☐ a. Check here if there were no record interest holders. b. Date of certified mailing: 12/19/2012 (mm/dd/yyyy)

☑ c. Check here to certify that names and addresses of all record holders notified is attached.

☑ 2. Check here to certify that within 30 days of recording and/or registering the AUL, including amending, releasing or terminating the AUL, a copy of the AUL was/will be provided to the Chief Municipal Officer, the Board of Health, the Zoning Official, and the Building Code Enforcement Official in the community(ies) where the the property subject to such Activity and Use Limitation is located.

☑ 3. Check here to certify that within 30 days of recording and/or registering the AUL, including amending, releasing or terminating the AUL, a Legal Notice was/will be published in a newspaper with circulation in the community(ies) where the property subject to the AUL is located.

☑ 4. Check here to certify that within 7 days of publishing a Legal Notice in a newspaper with circulation in the community(ies) where the property subject to the AUL is located, a copy of the notice was/will be submitted to DEP.

☑ 5. Check here to certify that within 30 days of recording and/or registering the AUL, including amending, releasing or terminating the AUL, a certified copy of the AUL, including the LSP Opininon containing the material facts, data, and other information, will be submitted to DEP.

☐ 6. Check here if any non-updatable information provided on this form is incorrect, e.g. Site Address/Location Aid. Send corrections to the DEP Regional Office.

☐ 7. If an **Evaluation of Changes in Land Uses/Activities and/or Site Conditions after a Response Action Outcome Statement** is being submitted, check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

G. CERTIFICATION OF OWNER OF PROPERTY, IF NOT PERSON SUBMITTING AUL TRANSMITTAL FORM:

1. I, __________, attest under the pains and penalties of perjury that I am the owner of said property(ies), subject to the AUL

2. __________ Signature 3. Date: __________ mm/dd/yyyy

4. Name of Organization:

5. Contact First Name: 6. Last Name:

7. Street: 8. Title:

9. City/Town: 10. State: 11. ZIP Code:

12. Telephone: 13. Ext.: 14. FAX:

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

ACTIVITY & USE LIMITATION (AUL) TRANSMITTAL FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

BWSC113

Release Tracking Number

3 - 208

H. CERTIFICATION OF PERSON MAKING SUBMITTAL:

1. I, **JOHN OLDHAM**, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

Pursuant to 310 CMR 40.1074 (1)(f), I also hereby certify under penalties of perjury, that either I (if person submitting the AUL Transmittal Form is the property owner), or

2. Name of Property Owner

am/is identified on the Notice of AUL as the owner of the property subject to the AUL, owned such property on the date that the AUL was recorded and /or registered

3. By: **JOHN OLDHAM** 4. Title: **PROJECT MGR**

Signature

5. For: **REICHHOLD INC** 6. Date: **2/12/2013**

(Name of person or entity recorded in Section D) mm/dd/yyyy

☐ 7. Check here if the address of the person providing certification is different from address recorded in Section D.

8. Street:

9. City/Town: 10. State: 11. ZIP Code:

12. Telephone: 13. Ext.: 14. FAX:

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO $10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. YOU MUST LEGIBLY COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

Date Stamp (DEP USE ONLY:)

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC113A

ACTIVITY & USE LIMITATION (AUL) OPINION FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

Release Tracking Number: 3 - 208

A. DISPOSAL SITE LOCATION:

1. Disposal Site Name: **REICHHOLD CHEMICALS INC FMR**

2. Street Address: **77 LOWELL JUNCTION RD**

3. City/Town: **ANDOVER** 4. ZIP Code: **05544-0000**

B. THIS FORM IS BEING USED TO: (check one)

- [x] 1. Provide the LSP Opinion for a **Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1074.
- [ ] 2. Provide the LSP Opinion for an **Evaluation of Changes in Land Uses/Activities and/or Site Conditions after a Response Action Outcome Statement,** pursuant to 310 CMR 40.1080. Include BWSC113A as an attachment to BWSC113. Section A and C do not need to be completed.
- [ ] 3. Provide the LSP Opinion for an **Amended Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1081(4).
- [ ] 4. Provide the LSP Opinion for a **Partial Termination of a Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1083(3) .
- [ ] 5. Provide the LSP Opinion for a **Termination of a Notice of Activity and Use Limitation**, pursuant to 310 CMR 40.1083(1)(d).
- [ ] 6. Provide the LSP Opinion for a **Grant of Environmental Restriction**, pursuant to 310 CMR 40.1071.
- [ ] 7. Provide the LSP Opinion for an **Amendment of a Grant of Environmental Restriction**, pursuant to 310 CMR 40.1081(3).
- [ ] 8. Provide the LSP Opinion for a **Partial Release of a Grant of Environmental Restriction**, pursuant to 310 CMR 40.1083(2).
- [ ] 9. Provide the LSP Opinion for a **Release of a Grant of Environmental Restriction**, pursuant to 310 CMR 40.1083(1)(c).
- [ ] 10. Provide the LSP Opinion for a **Confirmatory Activity and Use Limitation**, pursuant to 310 CMR 40.1085(4).

(Unless otherwise noted above, all sections of this form (BWSC113A) must be completely filled out, printed, stamped, signed with black ink and attached as an exhibit to the AUL Document to be recorded and/or registered with the Registry of Deeds and/or Land Registration Office.)

C. AUL INFORMATION:

1. Is the address of the property subject to AUL different from the disposal site address listed above?

- [x] a. No
- [ ] b. Yes

If yes, then fill out address section below.

2. Street Address:

3. City/Town: 4. ZIP Code:

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

BWSC113A

ACTIVITY & USE LIMITATION (AUL) OPINION FORM

Pursuant to 310 CMR 40.1056 & 40.1070 - 40.1084 (Subpart J)

Release Tracking Number

3 - 208

D. LSP SIGNATURE AND STAMP:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and 309 CMR4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> *if Section B indicates that a* ***Notice of Activity and Use Limitation*** *is being registered and/or recorded*, the Activity and Use Limitation that is the subject of this submittal (i) is being provided in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 310 CMR 40.1074;

> *if Section B indicates that an* ***Evaluation of Changes in Land Uses/Activities and/or Site Conditions after a Response Action Outcome Statement*** is being submitted, this evaluation was developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 310 CMR 40.1080;

> *if Section B indicates that an* ***Amended Notice of Activity and Use Limitation or Amendment to a Grant of Environmental Restriction*** *is being registered and/or recorded*, the Activity and Use Limitation that is the subject of this submittal (i) is being provided in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 40.1081;

> *if Section B indicates that a* ***Termination or a Partial Termination of a Notice of Activity and Use Limitation, or a Release or Partial Release of a Grant of Environmental Restriction*** *is being registered and/or recorded*, the Activity and Use Limitation that is the subject of this submittal (i) is being provided in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 310 CMR 40.1083;

> *if Section B indicates that a* ***Grant of Environmental Restriction*** *is being registered and/or recorded*, the Activity and Use Limitation that is the subject of this submittal (i) is being provided in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 310 CMR 40.1071;

> *if Section B indicates that a* ***Confirmatory Activity and Use Limitation*** *is being registered and/or recorded*, the Activity and Use Limitation that is the subject of this submittal (i) is being provided in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (ii) complies with 310 CMR 40.1085(4);

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

1. LSP #: **9415**

2. First Name: **JOHN D** 3. Last Name: **RENDALL**

4. Telephone: **(617) 523-2260** 5. Ext.: 6. FAX:

7. Signature: 8. Date:
mm/dd/yyyy

9. LSP Stamp:

Bk 13333 Pg27 #3448
02-04-2013 @ 10:17a

Form 1075

NOTICE OF ACTIVITY AND USE LIMITATION
M.G.L. c. 21E, § 6 and 310 CMR 40.0000

Disposal Site Name: Reichhold Chemicals, Inc.
DEP Release Tracking No.(s): **3-0208**

40

This Notice of Activity and Use Limitation ("Notice") is made as of this 4th day of February, 2013, by Reichhold Chemicals, Inc. (hereinafter, Reichhold) P.O. Box 13582 Research Triangle Park, NC 27709, together with its successors and assigns (collectively "Owner").

WITNESSETH:

WHEREAS, Reichhold is the owner(s) in fee simple of those certain parcel(s) of land located in Andover, Essex County, Massachusetts with the buildings and improvements thereon, pursuant to a deed recorded with the Northern Essex District Registry of Deeds in Book 4609, Page 63 and identified as "Parcel I" in Exhibit A of Access Easement Agreement in Book 10031, Page 229;

WHEREAS, said parcel(s) of land, which is more particularly bounded and described in Exhibit A, attached hereto and made a part hereof ("Property") is subject to this Notice of Activity and Use Limitation. The Property is shown as "Parcel I" on a plan recorded in the Northern Essex District Registry of Deeds as Plan Number PL-13859 and including Town of Andover Tax Assessors Map 159, Lots 1 through 4;

WHEREAS, a portion of the Property ("Portion of the Property") is subject to this Notice of Activity and Use Limitation. The Portion of the Property is more particularly bounded and described in Exhibit A-1, attached hereto and made a part hereof. The Portion of the Property is shown on a plan recorded with the Northern Essex District Registry of Deeds in Plan Number PL-16838 and on a sketch plan attached hereto and filed herewith for registration;

WHEREAS, the Portion of the Property comprises part of a disposal site as the result of a release of oil and/or hazardous material. Exhibit B is a sketch plan showing the relationship of the Portion of the Property subject to this Notice of Activity and Use Limitation to the boundaries of said disposal site existing within the limits of the Property and to the extent such boundaries have been established. Exhibit B is attached hereto and made a part hereof; and

WHEREAS, one or more response actions have been selected for the Portion of the Disposal Site in accordance with M.G.L. c. 21E ("Chapter 21E") and the Massachusetts Contingency Plan, 310 CMR 40.0000 ("MCP"). Said response actions are based upon (a) the restriction of human access to and contact with oil and/or hazardous material in soil and groundwater and (b) the restriction of certain activities occurring in, on, through, over or under the Portion of the Property. The basis for such restrictions is set forth in an Activity and Use Limitation Opinion ("AUL Opinion"), dated January, 2013, (which is attached hereto as Exhibit C and made a part hereof);

NOW, THEREFORE, notice is hereby given that the activity and use limitations set forth in said AUL Opinion are as follows:

1. Activities and Uses Consistent with the AUL Opinion. This AUL Opinion provides that a condition of No Significant Risk to health, safety, public welfare or the environment exists for any foreseeable period of time (pursuant to 310 CMR 40.0000) for the following activities and uses within the Portion of the Property Subject to AUL:

   (i) Commercial, industrial, and/or recreational uses and activities, including, but not limited to, pedestrian and vehicular traffic, landscaping, and routine maintenance of landscaped areas which do not cause and/or result in the disturbance of surface or subsurface soils below a depth of four (4) inches;

   (ii) Subsurface utility and/or subsurface construction activities, including excavation, subsurface drilling, and construction of any structures, provided that the activity is conducted in accordance with a Soil Management Plan developed by a Licensed Site Professional (LSP) prior to the initiation of such activities. Emergency repairs of existing utilities may be conducted without LSP involvement;

   (iii)Construction or renovation of buildings in the area provided slab-on-grade design/construction is utilized and includes engineered vapor intrusion controls, unless in the Opinion of a LSP these measures are not required to maintain a condition of No Significant Risk; and

   (iv)Such other activities and uses which, in the Opinion of an LSP, shall present no greater risk of harm to health, safety, public welfare or the environment than the activities and uses set forth in this paragraph.

2. Activities and Uses Inconsistent with the AUL Opinion. Activities and uses which are inconsistent with the objectives of this Notice of Activity and Use Limitation, and which, if implemented within the Portion of the Property Subject to AUL, may result in a significant risk of harm to health, safety, public welfare or the environment or in a substantial hazard, are as follows:

   (i) Use as a residence, school, daycare, or nursery;

   (ii) Use for commercial or non-commercial agricultural or farming purposes such as the cultivation of produce, crop growing, or the rearing of livestock;

   (iii)Any subsurface utility and/or subsurface construction activities not conducted in accordance with Obligations and Conditions (i) and (ii) or other provisions of this Notice of AUL;

   (iv)Relocation of soils to shallower depths unless such an activity is first evaluated by a LSP who renders an Opinion which attests that a condition of No Significant Risk of harm to human health, safety, public welfare, or the environment is maintained in accordance with the MCP; and

   (v) Construction or renovation of any building at the site without prior evaluation and rendering of an Opinion by a Licensed Site Professional (LSP) as to the need for engineered vapor intrusion controls for maintaining a condition of No Significant Risk.

3. Obligations and Conditions Set Forth in the AUL Opinion. Obligations and conditions applicable to the Portion of the Property Subject to AUL to maintain a condition of No Significant Risk include the following:

   (i) New building construction or renovation of existing buildings must be evaluated by an LSP to ensure that the basis and assumptions behind the risk assessment contained in the supporting Response Action Outcome (RAO) statement remain valid (i.e. the risk characterization assumptions are still applicable and new designs include engineered vapor intrusion controls); and

   (ii) A Soil Management Plan must be developed by a Licensed Site Professional and implemented prior to commencement of any subsurface, utility and/or construction activities that is likely to disturb surface or subsurface soils greater than four (4) inches in depth. The Soil Management Plan should describe appropriate soil excavation, handling, storage, transport, and disposal procedures and include a description of the engineering controls and air monitoring procedures necessary to ensure that workers and receptors in the vicinity are not affected by fugitive dust or particulates. On-site workers must be informed of the requirements of the Soil Management Plan, and the plan must be available on-site throughout the course of the project;

   (iii) Applicable worker health and safety practices set forth in 29 CFR 1910, 29 CFR 1926, and the MCP (310 CMR 40.0018) must be followed prior to and during any subsurface, utility and/or construction activities likely to disturb surface or subsurface soils greater than four (4) inches in depth or any activity including removal and/or disturbance of existing pavement or soil containing residual constituents. A Health and Safety Plan must be prepared by a Certified Industrial Hygienist or other qualified individual sufficiently trained in worker health and safety and be implemented prior to the commencement of any activities requiring the plan. The plan should describe the activity and specifically identify the types of personal protective equipment, monitoring devices, and engineering controls necessary to ensure that workers are not exposed to constituents through dermal contact, ingestion, and/or the inhalation of particulate dusts. Workers who may come in contact with soil must be informed of the location of residual constituents and all requirements of the Health and Safety Plan. The plan must be available on-site throughout the course of the project; and

   (iv) Response actions must be conducted in accordance with the Massachusetts Contingency Plan, 310 CMR 40.0000, should an LSP Opinion rendered pursuant to Obligation (i) conclude that future site uses and activities, including exposures associated with future building construction and occupation, are inconsistent with maintaining a condition of No Significant Risk.

4. Proposed Changes in Activities and Uses. Any proposed changes in activities and uses at the Portion of the Property which may result in higher levels of exposure to oil and/or hazardous material than currently exist shall be evaluated by an LSP who shall render an Opinion, in accordance with 310 CMR 40.1080 et seq., as to whether the proposed changes will present a significant risk of harm to health, safety, public welfare or the

environment. Any and all requirements set forth in the Opinion to meet the objective of this Notice shall be satisfied before any such activity or use is commenced.

5. Violation of a Response Action Outcome. The activities, uses and/or exposures upon which this Notice is based shall not change at any time to cause a significant risk of harm to health, safety, public welfare, or the environment or to create substantial hazards due to exposure to oil and/or hazardous material without the prior evaluation by an LSP in accordance with 310 CMR 40.1080 et seq., and without additional response actions, if necessary, to achieve or maintain a condition of No Significant Risk or to eliminate substantial hazards.

   If the activities, uses, and/or exposures upon which this Notice is based change without the prior evaluation and additional response actions determined to be necessary by an LSP in accordance with 310 CMR 40.1080 et seq., the owner or operator of the Portion of the Property subject to this Notice at the time that the activities, uses and/or exposures change, shall comply with the requirements set forth in 310 CMR 40.0020.

6. Incorporation Into Deeds, Mortgages, Leases, and Instruments of Transfer. This Notice shall be incorporated either in full or by reference into all future deeds, easements, mortgages, leases, licenses, occupancy agreements or any other instrument of transfer, whereby an interest in and/or a right to use the Property or a portion thereof is conveyed.

   Owner hereby authorizes and consents to the filing and recordation of this Notice, said Notice to become effective when executed under seal by the undersigned LSP, and recorded with the Northern Essex District Registry of Deeds.

   WITNESS the execution hereof under seal this 30 day of January, 2013.

Reichhold, Inc.
Owner

John Oldham

Mr. John Oldham
Director of Site Remediation

STATE OF NORTH CAROLINA

On this 30 day of January, 2013, before me, the undersigned notary public, personally appeared John Oldham, proved to me through satisfactory evidence of identification, which were DRIVERS LICENSE, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose.

As Director of Site Remediation for Reichhold, Inc., a corporation

Notary Public: Joan M. Grace
My Commission Expires: Nov. 6, 2014

JOAN M GRACE
NOTARY PUBLIC
WAKE COUNTY, NC

The undersigned LSP hereby certifies that he executed the aforesaid Activity and Use Limitation Opinion attached hereto as Exhibit C and made a part hereof and that in his Opinion this Notice of Activity and Use Limitation is consistent with the terms set forth in said Activity and Use Limitation Opinion.

Date: 1·31·13

Mr. John D. Rendall, LSP

COMMONWEALTH OF MASSACHUSETTS
JOHN
D.
RENDALL
No. 9415
REGISTERED
LICENSED SITE PROFESSIONAL

[LSP SEAL]

COMMONWEALTH OF MASSACHUSETTS

On this 31st day of January, 2013, before me, the undersigned notary public, personally appeared John D. Rendall, proved to me through satisfactory evidence of identification, which were license, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily for its stated purpose.

As LSP for CH2M HILL, Inc.

Notary Public: Bonnie Jeffery
My Commission Expires: 6/2/2015

Upon recording, return to:
John Oldham
Reichhold Chemicals, Inc.
P.O. Box 13582
Research Triangle Park, NC 27709

BONNIE JEFFERY
Notary Public, State of New York
Qualified in Wyoming County
LIC. [illegible]
My Commission Expires 6/2/2015

Exhibit A – Metes & Bounds of Parcel

QUITCLAIM DEED

31

BTL SPECIALTY RESINS CORP., a corporation duly established under the laws of Delaware and having its usual place of business at 2112 Sylvan Avenue, P.O. Box 2570, Toledo, Ohio 43606, for consideration paid, and in full consideration of One Dollar ($1.00), grants to **REICHHOLD CHEMICALS, INC.**, a corporation duly established under the laws of Delaware, of Research Triangle Park, North Carolina 27709 with *Quitclaim Covenants* the land in the Town of Andover, County of Essex, Massachusetts, as more particularly described on Exhibit A attached hereto and made a part hereof.

For Grantor's title, see Deed dated June 20, 1986 and recorded with Essex North Registry of Deeds in Book 2227, Page 164.

IN WITNESS WHEREOF, the said **BTL SPECIALTY RESINS CORP.** has caused its corporate seal to be hereto affixed and these presents to be signed, acknowledged and delivered in its name and behalf by Daniel Wozniak its President and Treasurer, hereunto duly authorized, this 26th day of September, 1996.

26594

WITNESS: Daniel Kalin

BTL SPECIALTY RESINS CORP.

By: Daniel Wozniak

Daniel Wozniak
President and Treasurer

OCT 10 '96 AM10:22

State of Ohio

, ss. September 26, 1996

Then personally appeared the above named Daniel Wozniak, President and Treasurer of BTL SPECIALTY RESINS CORP., and acknowledged the foregoing instrument to be his free act and deed and the free act and deed of said corporation, before me.

Essex Registry of Deeds
North District

Barbara Forgette
Notary Public
My commission expires: Mar. 25, 2000

BARBARA FORGETTE, Lucas County
Notary Public — State of Ohio
My Commission Expires

Return:
Burns + Levinson
125 Summer St.
Boston, MA 02110

EXHIBIT A

A certain parcel of land in the Town of Andover, County of Essex, Commonwealth of Massachusetts and located in that part of the town known as Lowell Jct. and situated on the northerly side of Lowell Jct. Road, a private way in said Town, said parcel having buildings thereon and being bounded and described as follows:

Beginning at the southeasterly corner thereof at a stake in the brook near the end of a 12" culvert and at other land of the grantee, said stake being located 106.97' westerly from a concrete bound on the said northerly side of said Lowell Jct. Road; thence running S-86°-17'-30"W. by the said northerly side of Lowell Jct. Road 258.43' to a spike at land of Edy Tyzbin; thence turning and running N. 9°-30' W by said land of Tyzbin 259.69' to a spike; thence running N. 4°-26'E. still by said land of Tyzbin 22.04' to a spike in the driveway between said property as herein described and said land of Tyzbin; thence turning and running N. 20°-47'-30" E. still by said land of Tyzbin 131.62' to an old iron pipe at the southerly bank of the Shawsheen River; thence turning and running in a general easterly and northeasterly direction by the said southerly bank of the Shawsheen River 151' more or less to other land of the grantee; thence turning and running S-88°-46'22" E. by said land of the grantee 63.50' to an iron pipe in the center of the Brook; thence turning and running S. 19°-06'-45" E. 62.13'; S. 0°-34'-15" W., 79.65'; S. 29°-37'-45" E., 87.55'; S-09°-58' E., 52.34'; S. 28°-03'-50" E., 34.37'; S. 05°-53'-48" W., 61.58' and S. 28°-38'-15" W., 64.89' to a stake in the northerly side of said Lowell Jct. Road and point of beginning; all of said last mentioned courses being by the center of the Brook and by said land of the grantee.

The land and buildings situated in said Ballardvale being bounded and described as follows:

Beginning at an iron pipe on the northerly line of Lowell Junction Road at land now or formerly of one Schultz; thence running north One Hundred Eighty-Seven and 7/100 (187.7') feet to an iron pipe; thence turning and running east along ditch Two Hundred Twenty Seven and 45/100 (227.45') feet to an iron pipe; thence turning and running north Thirty-Nine (39') feet to an iron pipe; thence turning and running easterly Four Hundred Eighty-One and 36/100

(481.36') feet to an iron pipe; thence turning at an interior angle of 90°00'30" and running southerly Sixty-Eight (68') feet to a stake; thence turning at an interior angle of 90° easterly; thence turning and running Two Hundred Twenty-Nine and 42/100 (229.42') feet to an iron pipe on the westerly line of the Lowell Branch of the Boston and Maine Railroad; thence turning and running northwesterly and westerly on the westerly line of said Railroad One Thousand Six Hundred Forty-Six (1646') feet to a point at the inter-section of said Railroad and the southerly line of Tewksbury Street; thence turning and running westerly along said southerly line of Tewksbury Street One Hundred Fifty-Seven (157') feet to an iron pipe; thence turning and running southeasterly in a straight line Six Hundred Fifty (650') feet more or less to the Shawsheen River, said line runs through an iron stake set in the ground about Forty (40') feet from the bank of the river, which iron stake is about Three Hundred Thirty-four (334') feet easterly in a straight line of a stone bound on the old county line known as Buck's Horn; thence continuing in a southwesterly direction along the center of a brook, which brook meets the Shawsheen River on its southern bank Six Hundred (600') feet more or less to an iron stake set in the center of said brook at its inter-section with the Lowell Junction Road; thence turning and running easterly along the northerly line of said Lowell Junction Road One Hundred Six and 97/100 (106.97') feet to the point of beginning.

The land in Andover, Massachusetts, bounded and described as follows:

Beginning at a Land Court bound set in the northerly line of Lowell Junction Road, Ballardvale, Massachusetts, said Land Court bound being at land of Watson Park Company, thence running north zero (0°) degrees and four (4) minutes west one hundred eighty seven and 70/100 (187.70') feet to a spike, thence turning and running north eighty nine (89°) degrees and fifteen (15) minutes east two hundred twenty seven and 45/100 (227.45') feet to an iron pipe, thence turning and running north zero (0°) degrees and forty five (45) minutes west thirty nine (39.00') feet to an iron pipe, thence turning and running north eighty five (85°) degrees twenty seven (27) minutes and thirty (30) seconds east one hundred ninety seven and 37/100 (197.37') feet to an iron pipe and land now or late of Schultz, thence turning and running south zero (0°) degrees and four minutes east by land now or late of Schultz two hundred forty six and 64/100 (246.64') feet to a Land Court bound set in the

northerly line of Lowell Junction Road, thence turning and running westerly along a circular arc having a radius of one thousand forty (1040.00') feet two hundred forty five and 04/100 (254.94') feet to a Land Court bound set at the Point of Curvature; thence running south eighty six (86°) degrees seventeen (17) minutes and thirty (30) seconds west along said northerly line of Lowell Junction Road one hundred eighty (180') feet to a Land Court bound which Land Court is the point of beginning, containing eighty seven thousand six hundred sixty (87,660) square feet more or less. All as shown on Plan of Land in Ballardvale, Massachusetts dated March 4, 1954 drawn by Charles E. Cyr, Civil Engineer, Lawrence, Massachusetts.

Certain parcels of land, and the buildings thereon, situated in that part of said Andover known as Ballardvale, said land being on the northerly side of Lowell Junction Road, and bounded and described as follows:

Parcel "A". Beginning at a land court bound on the northerly side of Lowell Junction Road formerly known as "Burt Road"; said bound abuts land owned by Reichhold Chemicals, Inc.; thence running in a northerly direction by land of Reichhold Chemicals, Inc. Two Hundred Forty-Six and 64/100 feet (246.64'), more or less, to an iron pipe; thence in an easterly direction by land of said Reichhold Chemicals, Inc. Two Hundred Eighty-Three and 96/100 feet (283.96'), more or less, to a stake; thence turning and running in a southerly direction by land of said Reichhold Chemicals, Inc. Sixty-Eight and 03/100 feet (68.03'), more or less, to a stake; thence turning and running in an easterly direction by land owned by said Reichhold Chemicals, Inc. to land of the Boston & Maine Railroad Two Hundred Twenty-Two and 68/100 feet (222.68'), more or less, to a stake; thence turning and running in a southeasterly direction by land of said Boston & Maine Railroad in two courses, Sixty-Two and 64/100 feet (62.64'), more or less, and Three Hundred Eighty-Six and 68/100 feet (386.68'), more or less, to a stake and land of unknown owners; thence turning and running in a southwesterly direction by land of said unknown owners, Forty-Four and 28/100 feet (44.28'), more or less, to a stake and Lowell Junction Road; thence turning and running northwesterly, southwesterly, and westerly in five courses along said line of Lowell Junction Road One Hundred and Thirty-Eight feet (138'), more or less, to a stake; Two Hundred Fifty-Two and 22/100 feet (252.22'), more or less, to a stake; One Hundred Seventy and 70/100

feet, (170.70'), more or less, to a stake; Two Hundred Sixteen and 95/100 feet (216.95'), more or less, to a stake; and Thirty-Nine and 96/100 feet (39.96'), more or less to the point of beginning.

Parcel "B". Beginning at a post at the corner of land owned by the Boston & Maine Railroad at the Shawsheen River; thence turning and running in a northwesterly direction by said river about One Hundred and Fifty feet (150'), more or less, to a stake in land owned now or formerly by one Frank Serio; thence turning and running in a southwesterly direction by land of said Serio Five Hundred Fifty-Five and 85/100 feet (555.85'), more or less, to a stake; thence turning and running in a northwesterly direction in two courses by said Serio land Twenty feet (20'), more or less, to a stake and Six Hundred Nineteen and 54/100 feet (619.54'), more or less, to a stake and the Shawsheen River; thence turning and running in a southwesterly direction by said river Forty-Five feet (45'), more or less, to a point and land of the Boston & Maine Railroad; thence turning and running in a southeasterly direction in four courses by land of said Boston & Maine Railroad Fourteen and 5/100 feet (14.05'), more or less, to a stake; Eighty-Six and 06/100 feet (86.06'), more or less, to a stake; Six Hundred Forty-Four and 96/100 feet (644.96'), more or less, to a stake; Two Hundred Eighty-Eight and 89/100 feet (288.89'), more or less, to a stake; thence turning and running in a northeasterly direction by land of said Boston & Maine Railroad Six Hundred and Forty-Three and 87/100 feet (643.87'), more or less, to the point of beginning.

All of the bounds mentioned above of Parcels A and B are more particularly described on a Plan of Land in Ballardvale, Massachusetts, dated June 21, 1956, drawn by Charles E. Cyr, Civil Engineer of Lawrence, Massachusetts, and said plan. Both Parcels A and B are subject to an easement running in favor of Frank Serio et al, and said easement is shown on said plan.

A certain parcel of land situated in said Andover, bounded and described as follows:

EASTERLY	by a private way, one hundred fifty feet;
SOUTHERLY	by other land of grantors, one hundred forty-eight and 3/10 feet;

WESTERLY by other land of grantors, one hundred fifty-three and 5/10 feet; and

NORTHERLY by other land of grantors, one hundred fifty-four and 5/10 feet.

Being the same premises shown on "Subdivision and Acceptance Plan of Land located in Andover, Mass., owned by Joseph A. Glorioso, November, 1964, revised December 18, 1964," which plan is recorded with North District of Essex Registry of Deeds as Plan #5196.

A certain parcel of land with the buildings thereon, situated in that part of Andover, County of Essex, Commonwealth of Massachusetts, known as Ballardvale, off Lowell Junction Road, containing 14 acres more or less, bounded and described as follows:

Beginning at a stake and stones on the Easterly side of the Shawsheen River at land late of Sarah J. Craig now of Reichhold Chemicals, Inc.; thence Northerly, Westerly and Southerly by said river (upstream) to a stake and stones at other land late of said Craig, now of said Reichhold Chemicals, Inc.; thence Easterly by said land late of Craig now of Reichhold Chemicals, Inc. as the fence stands 40 rods more or less to a stake and stones at other land late of said Craig now of Reichhold Chemicals, Inc.; thence by land late of said Craig now of Reichhold Chemicals, Inc. northeasterly as the wall stands 30 rods more or less to said river and the point of beginning.

The land in said Andover, on the Southeasterly side of Tewksbury Street, as re-located by the Commonwealth of Massachusetts by order of taking duly recorded with North Essex Registry of Deeds in 1958, said premises being bounded and described as follows:

NORTHWESTERLY by the Southeasterly line of said Tewksbury Street, 566 feet;

SOUTHWESTERLY by land formerly of Elmer E. Shattuck, now or formerly of Frederick T. Rouillard, 510 feet, more or less;

WESTERLY by said Rouillard land, 6 feet, more or less; the intersection between the last two bounds is a stone bound called "Buck's Horn";

SOUTHEASTERLY, EASTERLY and SOUTHEASTERLY by the Shawsheen River, 400 feet, more or less; and

NORTHEASTERLY by land formerly of Watson Park Company, now of Reichhold Chemicals, Inc., 690 feet, more or less, the last bound being set by an Indenture dated June 13, 1952, between the said Proulx and the said Watson Park Company recorded with said Registry of Deeds, Book 761, Page 557.

A certain parcel of land in the Town of Andover, County of Essex, Commonwealth of Massachusetts, being known and numbered as 79 and 81 Lowell Junction Road, with buildings thereon, said parcel is situated on the north side of Lowell Junction Road as shown on a plan entitled, "Plan Of Land In Andover, Massachusetts, (Ballardvale) As Surveyed For Reichhold Chemicals, Inc.", dated November, 1974, prepared by Clinton Foster Goodwin, Registered Land Surveyor, 25 Washington Square, Haverhill, Massachusetts, and being more particularly bounded and described as follows:

Beginning at the southeasterly most corner of said property, as a point on the northerly right of way of Lowell Junction Road (a public way), said point being marked by a concrete bound; thence,

WESTERLY along the northerly right of way of the said Lowell Junction Road 200.00 feet S86° 08' 00"W to a point, said point being the southeasterly most corner of property now/or formerly owned by Robert R. and Jean R. Scarano, formerly property of Fredericks; thence,

NORTHWESTERLY by said land now or formerly of Robert R. and Jean R. Scarano 121.84 feet N19° 17' 55"W to a point, said point being the northeasterly most corner of the aforementioned Scarano property; thence,

WESTERLY by the said Scarano property 123.59 feet S86° 45' 39"W to a point at land now of the Town of Andover; thence,

NORTHERLY in two courses by said Town of Andover land, 164.40 feet N3° 22' 52"E, and 183.19 feet N80° 19' 30"E, to a point at additional land now of the Town of Andover; thence,

EASTERLY in three courses by land of the said Town of Andover and by other land of the Grantee, 145.00 feet S08° 52' 00"E, 135.87 feet S31° 39' 30"E, and 81.00 feet S75° 24' 00"E, to a point at land of the Grantee; thence,

SOUTHERLY in three courses by land of the said Grantee, 131.62 feet S20° 47' 30"W, 22.04 feet S04° 26' 00"W, and 259.37 feet S09° 30' 00"E, to the point of beginning.

Together with and subject to the right of way referenced in deed recorded in Book 1353 at Page 443.

The property described in this Exhibit A is subject to the following additional encumbrances and exceptions:

1. "Order of Taking" by the Town of Andover dated April 15, 1968 and recorded in Book 1103, Page 493 and shown on plan recorded as Plan No. 5826.

2. "Order of Taking" by the Town of Andover dated May 20, 1968 and recorded in Book 1106, Page 237 and shown on plan recorded as Plan No. 5843.

3. "Order of Taking" by the Town of Andover recorded in Book 1106, Page 239 and shown on plan recorded as Plan No. 5844.

4. "Order of Taking" by the Town of Andover dated August 29, 1968 and recorded in Book 1113, Page 331 and shown on plan recorded as Plan No. 5900.

5. "Order of Taking" by the Town of Andover dated October 14, 1968 and recorded in Book 1117, Page 18 and shown on plan recorded as Plan No. 5930.

6. Taking by the Town of Andover as shown on plan recorded as Plan No. 1693..

* There is excepted and excluded from the foregoing described property, and from the premises conveyed hereby, the premises conveyed to Robert R. Scarano and Jean R. Scarano by deed dated April 17, 1989 and recorded with Essex North District Deeds Book 2934, Page 224.

7. Right and easement granted to Lawrence Gas & Electric Company dated December 21, 1955 and recorded in Book 828, Page 124.

8. Taking by the Department of Public Works of the Commonwealth of Massachusetts dated June 3, 1958 and recorded in Book 875, Page 156 and shown on plan recorded as Plan No. 3669.

9. License granted to Bay State Gas Company recorded in Book 1367, Page 599.

10. Right of way twenty feet wide set forth in deeds recorded in Book 299, Page 329 and Book 416, Page 15.

11. Subject to the rights of others in and to the right of way referenced in deed recorded in Book 1353 at Page 443.

12. Restrictive covenants and conditions and right of way set forth in deed from Frank Serio and Theresa Serio to Joseph A. Glorioso dated September 23, 1948 and recorded in Book 716, Page 48.

13. Restrictive covenants and conditions set forth in an instrument recorded in Book 1028, Page 127.

14. "Order of Taking" by the Public Works Commission of the Commonwealth of Massachusetts dated March 8, 1978 and recorded in Book 1334, Page 125 and shown on plan recorded as Plan No. 7785.

15. "Order of Conditions" issued by the Andover Conservation Commission recorded in Book 1397, Page 275.

16. "Order of Conditions" issued by the Andover Conservation Commission recorded in Book 1663, Page 67.

17. Right, title and interest in and to those parcels of land conveyed by Reichhold Chemicals, Inc. to John E. Deloury and George Morey by deed dated May 15, 1984 and recorded in Book 1815, Page 1 and shown on plan recorded as Plan No. 9476.

18. Driveway and fence maintenance agreement set forth in instruments recorded in Book 757, Page 506 and in Book 757, Page 507.

19. "Order of Conditions" issued by the Department of Environmental Protection recorded in Book 4230, Page 272.

20. Right, title and interest in and to that parcel of land containing .43 acres as shown on plan entitled "Plan of Land in Andover, Mass. Belonging to N.E. Plywood Co.", Scale 1 in=100 ft. dated June 3, 1920, Horace Hale Smith, Engineer, recorded as Plan No. 411.

21. All other easements, restrictions and encumbrances of record, if any, insofar as in force and applicable.

For title see deed from Reichhold Chemicals, Inc. to Grantor dated June 20, 1986 and recorded with Essex North District Registry of Deeds in Book 2227, Page 164.

See Plan 15315

ACCESS EASEMENT AGREEMENT

This EASEMENT ACCESS AGREEMENT is made as of the 27th day of January, 2006, by and between Reichhold, Inc., a duly established Delaware corporation with a principal place of business of Research Triangle Park, North Carolina 27709 ("Grantor"), and The Town of Andover, a duly established Massachusetts municipal corporation, with a principal place of business at 36 Bartlett Street, Andover, Massachusetts 01801 ("Grantee").

RECITALS:

A. Grantor is the owner of the real property more fully described in Exhibit A attached hereto and by this reference incorporated herein as though fully set forth (the "Grantor Property").

B. Grantor intends to convey the real property more fully described on Exhibit B attached hereto and by this reference incorporated herein as though fully set forth (the "Grantee Property"), which is adjacent to and generally to the north and east of the Grantor property.

C. Grantor and Grantee wish to establish an access easement across Grantor Property to the Grantee Property in the manner provided herein.

NOW, THEREFORE, in consideration of the foregoing and the mutual covenants contained herein, the parties hereto agree as follows:

AGREEMENT:

1. Grantor hereby grants to Grantee the right and easement, subject to the terms and conditions hereof, over that portion of the Grantor Property more fully described on Exhibit C and Schedule 1 attached hereto (the "Easement Area"), to construct, install, improve, including without limitation, pave and maintain, at Grantee's expense, and use as a way for all purposes for which driveways in Andover, Massachusetts may now or hereinafter be used, including the right

Nixon Peabody, LLP
100 Summer Street
Boston, MA 02110
Attn:

of travel by foot or vehicle in the Easement Area, for the benefit of the Grantee Property. As further depicted on Exhibit C and Schedule 1, the Easement Area shall not exceed a maximum width of twenty-six feet (26'), and shall terminate at the northern edge of the Grantor Property where it abuts the railroad right-of-way (a strip of property that is not owned by either Grantor or Grantee). Grantee expressly acknowledges that Grantor has made no representations or promises regarding passage over the railroad right-of-way at the termination of the Easement Area.

2. The rights herein granted to Grantee are non-exclusive, are solely for the benefit of the Grantee Property, are to run with the Grantee Property, and are to be exercised in common with Grantor and the successors and assigns of Grantor and Grantee.

3. All rights granted to Grantee in the Easement Area are subject to the following terms and conditions:

a) As further depicted on Exhibit C and Schedule 1, Grantee shall install and maintain a gate and lock for accessing the Easement Area from Lowell Junction Road (providing a key to Grantor), and shall install and maintain a fence along the west boundary of the Easement Area extending north from the gate to the boundary of the railroad right-of-way property, sufficient to reasonably block public access to the Grantor Property from the Easement Area.

b) All construction, maintenance and repair costs concerning the Easement Area shall be borne by Grantee, including (without limitation) in connection with the aforementioned gate and fencing, but excluding the costs of utilities or other improvements installed by Grantor for the benefit of the Grantor Property.

c) Grantor and Grantee agree to provide prior notice to the other whenever either of them shall exercise rights under this Paragraph in the Easement Area. The party exercising such rights agrees that such rights shall be exercised so as to cause minimum interference with rights of others and that upon completion of any construction the surface of the Easement Area and any other areas disturbed and any structures in, on or under any of such areas

which are disturbed or injured shall be restored substantially to their previous condition.

d) Grantor expressly reserves and retains the right to use and to grant others the right to use the surface or subsurface of all or any portion of such Easement Area; provided, however, that such use shall not materially and adversely interfere with the rights of Grantee hereunder.

e) Grantee shall not permit or suffer the imposition of any materialman's or mechanic's lien affecting the Easement Area and, if a notice of contract or subcontract is filed or a lien otherwise established affecting the Easement Area, Grantee shall promptly cause the same to be released, discharged, or bonded-off as provided by law.

f) Grantee agrees to be responsible for its negligence in exercising its rights pursuant to this Agreement; provided, however, that Grantee shall not be responsible for the negligence of Grantor (each reserving all applicable defenses).

4. This Agreement shall be governed by the laws of the Commonwealth of Massachusetts, exclusive of its choice-of-law provisions, and may be enforced only in a Massachusetts court of competent jurisdiction.

[Signatures to Follow on Next Page]

Executed as a sealed instrument as of the 3rd day of February, 2006.

GRANTOR:

REICHHOLD, INC.

By: ______________________
Name: John S. Gaither
Title: President

STATE OF North Carolina)
) ss.
COUNTY OF Wake)

On this 3rd day of February, 2006, before me, the undersigned, a Notary Public in and for the State of North Carolina, duly commissioned and sworn, personally appeared John S. Gaither, President of Reichhold, Inc., the corporation that executed the within and foregoing instrument, and acknowledged said instrument to be the free and voluntary act and deed of said corporation for the uses and purposes therein mentioned, and on oath stated that he was duly elected, qualified and acting as said officer of the corporation, that he was authorized to execute said instrument and that the seal affixed, if any, is the corporate seal of said corporation.
IN WITNESS WHEREOF I have hereunto set my hand and official seal the day and year first above written.

____
(Signature of Notary)

____
(Print or stamp name of Notary)
NOTARY PUBLIC in and for the State of North Carolina.

Notary Public
Wake County
State of North Carolina

GRANTEE:

THE TOWN OF ANDOVER, a Municipal corporation

By: Reginald S. Stapczynski

Name: Reginald S. Stapczynski

Title: Town Manager

The Commonwealth of Massachusetts)
) ss.
County of Essex)

February 6
~~January~~ ____, 2006

On this 6 day of February ~~January~~, 2006, before me, the undersigned notary public, personally appeared Reginald S. Stapczynski Town Manager of The Town of Andover, a municipal corporation, who proved to me through ~~satisfactory~~ evidence of identification, which was his/her Massachusetts Drivers License, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he/she signed voluntarily for its stated purpose.

Donald D. Cooper
Notary Public
Commonwealth of Massachusetts
My Commission Expires: November 8, 2009

9061564611.1

Exhibit A

(Grantor's Land [Parcel I])

A certain parcel of land with the buildings and improvements thereon in Andover, Essex County (North Registry District), Massachusetts, situated between Lowell Junction Road in said Andover and the Shawsheen River, bounded Southeasterly and Southerly by Lowell Junction Road in several course and curves, 42.60 feet, 335.36 feet, 209.00 feet, 697.89 feet, and 411.92 feet Southwesterly by land nor or formerly of Genetics Institute Inc., 425.53 feet; Northwesterly by the Shawsheen River, approximately 1012 feet and Northeasterly by land now or formerly of Massachusetts Bay Transportation Authority (formerly Boston and Maine Railroad) a distance of approximately 664 feet and along a curve of approximately 490 feet. The parcel is further shown as "Parcel I" on a plan entitled "Activity & Use Limitation Plan, Lowell Junction Road & Tewksbury Street, Andover, MA," prepared by by SMC (Surveying and Mapping Consultants) of Braintree, Massachusetts, dated May 23, 2000, and recorded with Essex North District Registry of Deeds as Plan 13859 on October 23, 2000.

Exhibit B

(Grantee's Land [Parcel III])

A certain parcel of land in Andover, Essex County (North Registry District), Massachusetts, and situated between the Shawsheen River in said Andover and the Boston and Maine Railroad, bounded Northwesterly, Northerly and Northeasterly by the Shawsheen River, approximately 4,998 feet Southeasterly by land now or formerly of Massachusetts Bay Transportation Authority approximately 633 feet and Southerly and Southwesterly by other land now or formerly of Massachusetts Bay Transportation Authority (formerly Boston and Maine Railroad) along a curve approximately 304 feet and in a straight line approximately 723 feet. The parcel is further shown as "Parcel III" on a plan entitled "Activity & Use Limitation Plan, Lowell Junction Road & Tewksbury Street, Andover, MA," prepared by by SMC (Surveying and Mapping Consultants) of Braintree, Massachusetts, dated May 23, 2000, and recorded with Essex North District Registry of Deeds as Plan 13859 on October 23, 2000.

Exhibit C

(Easement Area)

The Land in Andover, Massachusetts, commencing on Lowell Junction Road, as shown on the sketch, attached hereto as Schedule 1 entitled "Land Title Survey Lowell Junction Road and Tewksbury Street, Andover, Massachusetts", prepared by SMC of 170 Forbes Road, Braintree, Massachusetts, at a point which is extrapolated from the southwesterly corner of the cart path shown on said sketch to a point located on the northern boundary of Lowell Junction Road, running easterly along said Lowell Junction Road to a point which is five feet east of a point which is extrapolated from the southeasterly corner of the cart path to a point located on the northern boundary of Lowell Junction Road, then turning and running northerly in lines parallel with the easterly boundary of such cart path and a distance of five feet therefrom, to the boundary of Grantee's Property, then turning northwest and running along the southern boundary of the Grantee's Property to a point which is five feet west of the westerly boundary of said cart path along said boundary, then turning and running southerly in lines parallel with the westerly boundary of said cart path to Lowell Junction Road and a distance of five feet therefrom, then turning east and running along the northerly boundary of Lowell Junction Road to the point of beginning, and at all points possessing a maximum width of twenty-six (26') or less.

Exhibit A-1 Metes & Bounds of AUL- Former Manufacturing Area

Exhibit A-1
Metes & Bounds
AUL – Former Manufacturing Area

A parcel of land located on the north side of Lowell Junction Road, beginning at the southwest corner, at a point on the north sideline of Lowell Junction Road, at land of Genetics Institute, Inc., running:

N 19° 50' 50" W	425.33'	along land of Genetics Institute, Inc., to a point on the south bank of the Shawsheen River, thence
Easterly	1053'±	along the south bank of the Shawsheen River to a point at the land of Massachusetts Bay Transportation Authority, thence
S 64° 40' 20" E	135.84'	along land of Massachusetts Bay Transportation Authority to a point at AUL Area B, thence
S 06° 41' 53" W	492.44'	along AUL Area B to a point on Lowell Junction Road, thence along a curve to the left along Lowell Junction Road
R=4025.00'	L=340.12'	to a point, thence along Lowell Junction Road
S 69° 44' 22"	209.00'	to a point, thence along Lowell Junction Road
S 69° 20' 12"	335.36'	to a point, thence along Lowell Junction Road
S 70° 35' 04" W	42.60'	to a point at land of Genetics Institute, Inc. said point being the point of beginning.

Said parcel contains 463,543 square feet or 10.6415 acres of land area and is shown as AUL – Former Manufacturing Area on PLAN OF AUL – FORMER MANUFACTURING AREA in Andover, Massachusetts prepared for Reichhold Chemicals, Inc. , December 17, 2012, Scale 1"=100' by Merrimack Engineering Services, Inc. 66 Park Street, Andover, MA 01810.

Exhibit B Sketch Plan – Disposal Site and FMA AUL

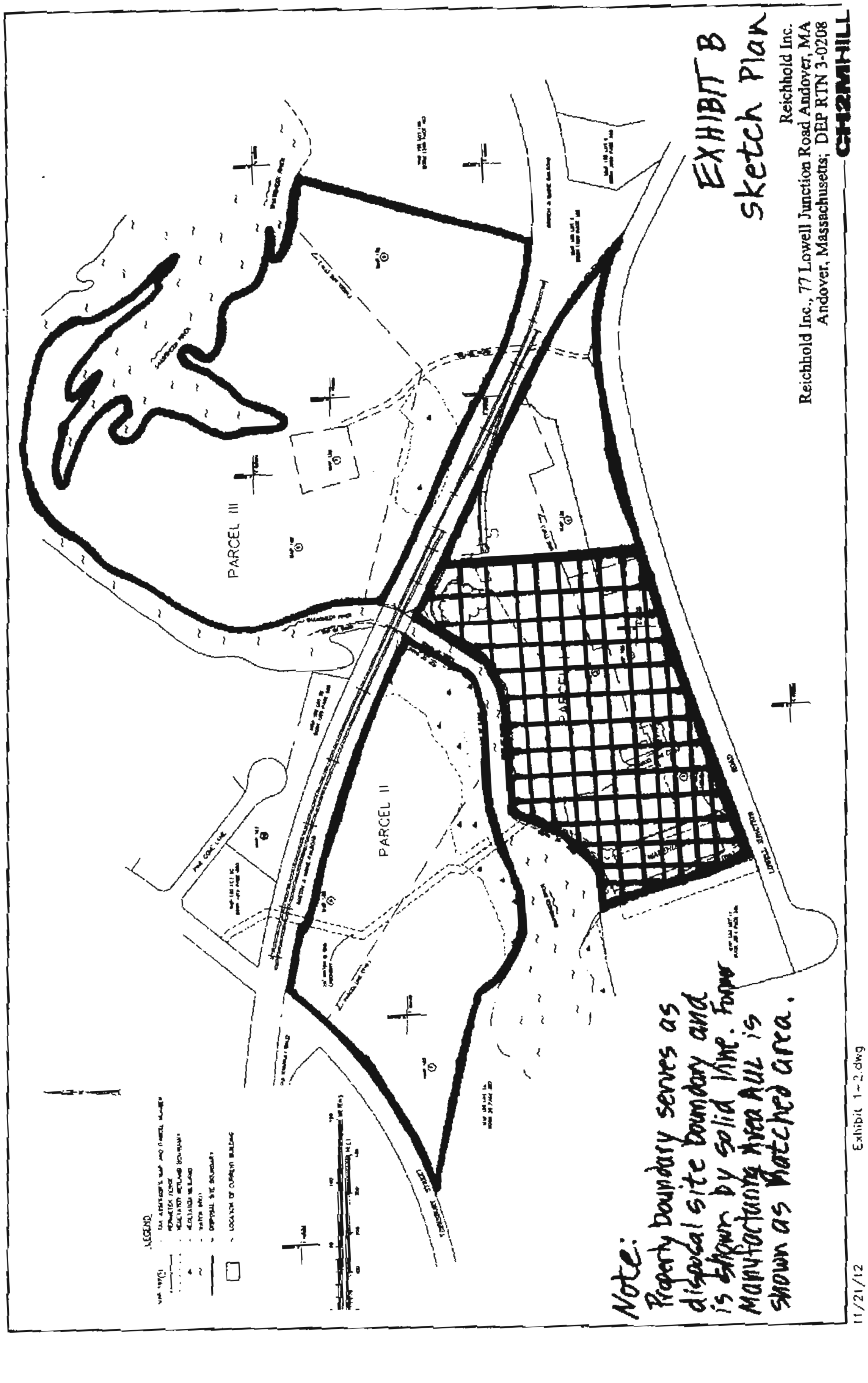


EXHIBIT B
Sketch Plan
Reichhold Inc.
Reichhold Inc., 77 Lowell Junction Road Andover, MA
Andover, Massachusetts; DEP RTN 3-0208
CH2MHILL
PARCEL III
PARCEL II
LEGEND
Note:
Property boundary serves as
disposal site boundary and
is shown by solid line. Former
Manufacturing Area AUL is
shown as hatched area.
Exhibit 1-2.dwg
11/21/12

Exhibit C FMA AUL Opinion

Exhibit C
Activity and Use Limitation Opinion-
Parcel I Former Manufacturing Area
Reichhold, Inc.
77 Lowell Junction Road
Andover, MA 01810
DEP RTN 3-0208

In accordance with the requirements of 310 CMR 40.1074, this Licensed Site Professional (LSP) Opinion has been prepared to support a Notice of Activity and Use Limitation (AUL) for the Former Manufacturing Area (FMA) sub-portion of a parcel of land, Parcel I, owned by Reichhold Inc, located at 77 Lowell Junction Road Andover, Essex County, Massachusetts, 01810. The FMA is part of the Reichhold, Inc. (Reichhold) site, identified by the Massachusetts Department of Environmental Protection (MADEP) as RTN 3-0208.

Site Background

The Reichhold site (herein after referred to as "the site"), RTN 3-0208, is estimated at approximately 44.7 acres based on current survey information, and is divided into three Parcels as identified in Exhibit B (Sketch Plan). Parcel I, estimated at approximately 14.6 acres, was the location of the former manufacturing facility (FMA) and a former industrial landfill (LFA). Parcel II to the northwest, estimated at approximately 11.2 acres, consists of both upland and a wetland areas. The upland area of Parcel II was the location of six former waste lagoons and a concrete equalization basin. No known industrial activities occurred in the wetland area of Parcel II. Parcel III to the northeast, estimated at approximately 18.9 acres and currently undeveloped land, has had no known industrial activity associated with it.

This LSP Opinion is being prepared in support of a Notice of AUL for the FMA portion of Parcel I (Portion of the Property Subject to AUL). Separate Notices of AULs have previously been filed for Parcel III and Parcel II, as part of Class A-3 Partial Response Action Outcome Statements (RAO-P), and for the eastern portion of Parcel I, referred to as the former landfill area (LFA), as part of a Class A-3 RAO-P. These AULs have been prepared and filed separately with the MADEP and Northern Essex Registry of Deeds. Response actions conducted in recent years, including monitoring and risk assessment, support this AUL opinion for the remaining FMA portion of Parcel I.

The MADEP assigned release tracking number (RTN) 3-0208 to the Reichhold site, which has since been classified as a Tier II site under the Massachusetts Contingency Plan (MCP), 310CMR 40.0000 (MADEP, 1993 et seq.). The site is also classified as a Public Involvement Plan (PIP) site.

According to the Town of Andover Tax Assessor's office, the Reichhold site is further identified as Lots 1, 2, 3, 4 and 8 on Tax Map 159 and Lots 6 and 7 on Tax Map 182. The site is located in an area zoned for industrial, mixed residential/industrial and residential use.

Specifically, according to the Town of Andover's Zoning Map, Lots 1, 2, 3 and 4 of Map 159 are zoned Industrial A, Lots 6 and 7 of Map 182 are zoned Industrial G, and Lot 8 of Map 159 is zoned Single Residence B. The FMA Portion of the Property Subject to this Notice of AUL, identified to be portions of Lots 1 through 4 of Town of Andover Tax Assessor's Map 159, is a 10.6 acre area located in the southeastern corner of Parcel I.

Site History

The property located at 77 Lowell Junction Road was purchased by Watson Park Company in November 1930. Prior to Watson Park's ownership, the property was known as New England Plywood. The property was purchased by Reichhold from Watson Park in 1953. Reichhold owned the property from 1953 until June 1986 at which point it was sold to BTL Specialty Resins, Inc. (BTL). At the property, Watson Park, Reichhold and BTL produced phenolic compounds and urea formaldehyde resins for use in many industries.

BTL closed the facility in February 1990, and it has not been in operation since. In September 1996, Reichhold re-acquired the site from BTL for the purpose of facilitating remedial activities under the MCP.

Summary of Comprehensive Response Actions

The site was first listed in the MADEP's August 1993 Transition List of Confirmed Disposal Sites and Locations to be Investigated (LTBI) on January 15, 1987 and was issued Release Tracking Number (RTN) 3-0208. In June 1995, Reichhold retained CH2M HILL to provide Licensed Site Professional (LSP) services for the site. Although BTL owned the property at the time, Reichhold assumed the lead role in the site remediation process and continued in that role after re-acquiring the site from BTL in 1996. On or before August 2, 1995, a Phase I - Initial Site Investigation (ISI) Report, a Numerical Ranking System (NRS) scoresheet, and a Tier Classification Submittal in accordance with the MCP regulations (310 CMR 40.0840, 40.1500 and 40.0500) were submitted to the MADEP on behalf of Reichhold. The Phase I ISI identified three areas of concern: the former Equalization Basin Area (EBA), the former Landfill Area (LFA), and the former Manufacturing Area (FMA). In September 1996, subsequent to the Phase I ISI submittal to the MADEP, the site was re-acquired by Reichhold in order to facilitate remedial activities under the MCP.

Beginning in 1997, Reichhold conducted several MCP response actions at the site including extensive soil removal, in-situ groundwater treatment, and monitored natural attenuation (MNA). Soil remedial actions, consisting of source removal and offsite disposal, were successfully completed in January 1999 as documented in a Phase IV - Final Inspection Report (FIR) (CH2M HILL, July 1999). The primary approach for addressing residual soil and groundwater contamination at the site has been intrinsic bioremediation through MNA following source removal. In addition to MNA, soil and groundwater have been treated with Oxygen Release Compound (ORC®), EHC®, and in-situ chemical oxidation (ISCO) involving alkaline-activated sodium persulfate to enhance the natural biodegradation of the residual contaminants.

Detailed information relating to the site assessment and remedial response actions is provided in the following reports:

CH2M HILL, 1995. Phase I - Initial Site Investigation, 77 Lowell Junction Road, Andover, Massachusetts. RTN 3-0208. June 1995.

CH2MHILL, 1996. Public Involvement Plan, 77 Lowell Junction Road, Andover, Massachusetts. RTN 3-0208. September 1996.

CH2M HILL, 1997a. Analytical Report, Reichold-Andover, 77 Lowell Junction Road, Andover, MA RC917 RTN 3-0208. February 28, 1997.

CH2M HILL, 1997b. Phase II – Comprehensive Site Assessment, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. August 1997.

CH2M HILL, 1997c. Phase III – Remedial Action Plan, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. October 1997.

CH2M HILL, 1997d. Phase IV – Remedy Implementation Plan, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. November 1997.

CH2M HILL, 1999a. Phase IV – Final Inspection Report, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. July 1999.

CH2M HILL, 1999b. Well Abandonment Report, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. July 1999.

CH2M HILL, 1999c. Phase V – Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. December 1999.

CH2M HILL, 2000a. Phase IV – Remedy Implementation Plan Addendum, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. June 2000.

CH2M HILL, 2000b. Documentation Supporting a Class C Response Action Outcome Statement, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. July 2000.

CH2M HILL, 2000c. Phase V – Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. July 2000.

CH2M HILL, 2000d. Phase IV – Final Inspection Report Addendum, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. December 2000.

CH2M HILL, 2001. 2000 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA. RTN 3-0208. April 2001.

CH2M HILL, 2002. 2001 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA. RTN 3-0208. May 2002.

CH2M HILL, 2003. 2002 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA. RTN 3-0208. November 2003.

CH2M HILL, 2004a. 2003 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA. RTN 3-0208. June 2004.

CH2MHILL, 2004b. Phase IV – Remedy Implementation Plan Addendum, 77 Lowell Junction Road, Andover, MA. RTN 3-0208. June 2004.

CH2M HILL, 2004c. Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel II [non-wetland portion]. RTN 3-0208. December 2004.

CH2M HILL, 2004d. Documentation Supporting a Class A-2 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel III, 77 Lowell Junction Road, Andover, MA. RTN3-0208 November 2004.

CH2M HILL, 2004e. Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel II [non-wetland portion]. 77 Lowell Junction Road, Andover, MA. RTN3-0208 December 2004.

CH2M HILL, 2004f. Documentation Supporting a Class A-3 Permanent Solution Partial Action Outcome Statement - Parcel I Former Landfill Area. 77 Lowell Junction Road, Andover, MA. RTN 3-0208. December 2004.

CH2M HILL, 2004g. Activity and Use Limitation – Parcel 1 Former Landfill Area, 77 Lowell Junction Road, Andover, MA RTN 3-0208 December 2004.

CH2M HILL, 2005a. 2004 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. July 2005.

CH2M HILL, 2005b. Class-C RAO Temporary Solution Five Year Periodic Review Opinion Statement, 77 Lowell Junction Road, Andover, MA RTN 3-0208 July 2005

CH2M HILL, 2005c. Phase IV – Final Inspection Report Addendum, 77 Lowell Junction Road, MA RTN 3-0208. November 2005.

CH2M HILL, 2005d. Amendment to Notice of Activity and Use Limitation – Parcel II (not including the wetlands area), 77 Lowell Junction Road, Andover, MA RTN 3-0208 December 2005.

CH2M HILL, 2006a. Remedy Implementation Plan Addendum, 77 Lowell Junction Road, Andover, MA RTN 3-0208 May, 2006.

CH2M HILL, 2006b. 2005 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. October 2006.

CH2M HILL, 2007. 2006 Post-Class C Response Action Outcome Status Report, 77 Lowell Junction Road, MA RTN 3-0208. October 2007.

CH2M HILL, 2008a. January – June 2007 Post RAO Operation Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208. January 2008.

CH2M HILL, 2008b. July – December 2007 Post RAO Operation Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208. April 2008.

CH2M HILL, 2008c. Activity and Use Limitation Amendment, Parcel I – Former Landfill Area, 77 Lowell Junction Road, Andover, MA RTN 3-0208 June 2008.

CH2M HILL, 2008d. Phase IV-Final Inspection Report – Addendum, 77 Lowell Junction Road, Andover, MA RTN 3-0208 June 2008.

CH2M HILL, 2008e. Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome (RAO) Statement - Parcel I Landfill Area. 77 Lowell Junction Road, Andover, MA RTN3-0208 July 2008.

CH2M HILL, 2008f. January – June 2008 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. November 2008.

CH2M HILL, 2009a. Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome Statement - Parcel II Wetlands Area, RTN 3-0208 March 2009.

CH2M HILL, 2009b. Revised Documentation Supporting a Class A-3 Permanent Solution Partial Response Action Outcome Statement - Parcel I Former Landfill Area, RTN 3-0208. April 2009.

CH2M HILL, 2009c. July – December 2008 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. July 2009.

CH2M HILL, 2009d. January – June 2009 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. September 2009.

CH2M HILL, 2010. July – December 2009 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. June 2010.

CH2M HILL, 2011a. January – December 2010 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, MA RTN 3-0208. April 2011.

CH2M HILL, 2011b. January – June 2011 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208. December 2011.

CH2M HILL, 2012. July - December 2011 Post RAO Operation, Maintenance, and Monitoring Report, 77 Lowell Junction Road, Andover, MA RTN 3-0208. March 2012.

These reports are available for review at the following locations:

Massachusetts Department of Environmental Protection, Northeast Regional Office, 205B Lowell Street Wilmington, Massachusetts or the MADEP web site, http://public.dep.state.ma.us/fileviewer/Rtn.aspx?rtn=3-0000208.

The Andover Memorial Library, Reference Desk in Andover, Massachusetts

The Andover Board of Health, Town Offices, Bartlett Street in Andover, Massachusetts

History of Response Actions - Parcel I Former Manufacturing Area

In 1998, remedial activities were performed at the former Manufacturing Area (FMA) portion of the site. Remedial actions included excavation and off-site disposal of contaminated soils/resins, removal of a concrete tank farm, excavation of a 500-gallon concrete sump within the loading dock area of the former manufacturing building, excavation of the kettle building sump, and removal of wastes and stormwater piping (CH2M HILL, 1999a). Excavated areas were backfilled with imported fill. The Andover Conservation Commission approved alternative restoration involving placement of a woven geotextile barrier and six inches of 3-inch minus stone over all excavation areas and areas where asphalt had been removed (CH2M HILL, 1999a).

In July 2000 and October/November 2001, FMA groundwater was treated with Oxygen Release Compound (ORC®) to enhance the natural biodegradation of the residual contaminants. Details of the ORC® applications are discussed in the Phase IV – FIR Addendum (CH2M HILL, December 2000d), and previous Operational, Maintenance and Monitoring Reports (OMM) (CH2M HILL, 2000c, 2001, and 2002).

A 2003 direct push technology (DPT) study indicated that an upgradient source of ethylbenzene was still present in the FMA, specifically in the former manufacturing building (*2003 Post-RAO OMM Report*, CH2M HILL, 2004). Based on these results, the former manufacturing and former kettle buildings were demolished in 2004 and additional subsurface soils were excavated and disposed of off-site. A detailed summary of the remedial activities conducted at the FMA can be found in the *Phase IV – Final Inspection (FI) Report* (CH2M HILL, 1999a) and the *Phase IV- FIR Addendum* (CH2M HILL, 2005b).

In September 2004, EHC®, a combination of controlled-release solid carbon and zero-valent iron (ZVI) particles that stimulate bioremediation of persistent organic solvents in groundwater and source zones, was applied to groundwater via trenches. The EHC® application was identified in the 2004 OMM report (CH2M HILL, 2005a).

With the exception of a June 2006 in-situ chemical oxidation (ISCO) application (further described below), activities at the FMA since 2004 have included routine groundwater sampling to assess MNA and soil investigation activities (testpitting, soil boring advancement and subsurface soil sampling, concrete pad removal, surface soil sampling, and surface water sampling) to determine if additional source areas exist within the former FMA. No additional source areas have been identified.

In June 2006, 12,500 lbs of activated sodium persulfate and 2,250 lbs of sodium hydroxide were injected into the FMA groundwater. Post ISCO groundwater sampling documented that the primary COCs, xylene and ethylbenzene, were reduced by 88% to 99% in four of the six observations wells, and 25 to 55% in the other two wells. OMM groundwater sampling conducted since 2007 indicates that constituents of concern still are present at the site, but have been declining since monitoring was initiated.

Reason for Activity and Use Limitation (AUL)

A Method 3 (site-specific) risk characterization was performed for the area inclusive of the FMA Portion of the Property Subject to AUL. The Method 3 concludes that the area poses no significant risk (NSR) to human health, safety, public welfare or the environment under current industrial/commercial land usage. The expected future use is to be restricted by AUL to industrial and recreational uses consistent with the Method 3, to assure that the FMA poses NSR for the authorized future uses.

This AUL Opinion describes prohibitions relating to human access and contact with any residual oil and/or hazardous material still remaining in soil and groundwater. This AUL requires a Health and Safety Plan and oversight by an LSP in the event that subsurface activities are proposed to be undertaken. Activities and uses consistent and inconsistent with this AUL Opinion, as well as obligations and conditions, are identified below.

1. <u>Activities and Uses Consistent with the AUL Opinion.</u> This AUL Opinion provides that a condition of No Significant Risk to health, safety, public welfare or the

environment exists for any foreseeable period of time (pursuant to 310 CMR 40.0000) for the following activities and uses within the Portion of the Property Subject to AUL:

(i) Commercial, industrial, and/or recreational uses and activities, including, but not limited to, pedestrian and vehicular traffic, landscaping, and routine maintenance of landscaped areas which do not cause and/or result in the disturbance of surface or subsurface soils below a depth of four (4) inches;

(ii) Subsurface utility and/or subsurface construction activities including, excavation, subsurface drilling, and construction of any structures, provided that the activity is conducted in accordance with a Soil Management Plan developed by a Licensed Site Professional (LSP) prior to the initiation of such activities. Emergency repairs of existing utilities may be conducted without LSP involvement;

(iii) Construction or renovation of buildings in the area provided slab-on-grade design/construction is utilized and includes engineered vapor intrusion controls, unless in the Opinion of a LSP these measures are not required to maintain a condition of No Significant Risk; and

(iv) Such other activities and uses which, in the Opinion of an LSP, shall present no greater risk of harm to health, safety, public welfare or the environment than the activities and uses set forth in this paragraph.

2. Activities and Uses Inconsistent with the AUL Opinion. Activities and uses which are inconsistent with the objectives of this Notice of Activity and Use Limitation, and which, if implemented within the Portion of the Property Subject to AUL, may result in a significant risk of harm to health, safety, public welfare or the environment or in a substantial hazard, are as follows:

(i) Use as a residence, school, daycare, or nursery;

(ii) Use for commercial or non-commercial agricultural or farming purposes such as the cultivation of produce, crop growing, or the rearing of livestock;

(iii) Any subsurface utility and/or subsurface construction activities not conducted in accordance with Obligations and Conditions (i) and (ii) or other provisions of this Notice of AUL;

(iv) Relocation of soils to shallower depths unless such an activity is first evaluated by a LSP who renders an Opinion which attests that a condition of No Significant Risk of harm to human health, safety, public welfare, or the environment is maintained in accordance with the MCP; and

(v) Construction or renovation of any building at the site without prior evaluation and rendering of an Opinion by a Licensed Site Professional (LSP) as to the need for engineered vapor intrusion controls for maintaining a condition of No Significant Risk.

3. Obligations and Conditions Set Forth in the AUL Opinion. Obligations and conditions applicable to the Portion of the Property Subject to AUL to maintain a condition of No Significant Risk include the following:

   (i) New building construction or renovation of existing buildings must be evaluated by an LSP to ensure that the basis and assumptions behind the risk assessment contained in the supporting Response Action Outcome (RAO) statement remain valid (i.e. the risk characterization assumptions are still applicable and new designs include engineered vapor intrusion controls); and

   (ii) A Soil Management Plan must be developed by a Licensed Site Professional and implemented prior to commencement of any subsurface, utility and/or construction activities that is likely to disturb surface or subsurface soils greater than four (4) inches in depth. The Soil Management Plan should describe appropriate soil excavation, handling, storage, transport, and disposal procedures and include a description of the engineering controls and air monitoring procedures necessary to ensure that workers and receptors in the vicinity are not affected by fugitive dust or particulates. On-site workers must be informed of the requirements of the Soil Management Plan, and the plan must be available on-site throughout the course of the project;

   (iii) Applicable worker health and safety practices set forth in 29 CFR 1910, 29 CFR 1926, and the MCP (310 CMR 40.0018) must be followed prior to and during any subsurface, utility and/or construction activities likely to disturb surface or subsurface soils greater than four (4) inches in depth or any activity including removal and/or disturbance of existing pavement or soil containing residual constituents. A Health and Safety Plan must be prepared by a Certified Industrial Hygienist or other qualified individual sufficiently trained in worker health and safety and be implemented prior to the commencement of any activities requiring the plan. The plan should describe the activity and specifically identify the types of personal protective equipment, monitoring devices, and engineering controls necessary to ensure that workers are not exposed to constituents through dermal contact, ingestion, and/or the inhalation of particulate dusts. Workers who may come in contact with soil must be informed of the location of residual constituents and all requirements of the Health and Safety Plan. The plan must be available on-site throughout the course of the project; and

   (iv) Response actions must be conducted in accordance with the Massachusetts Contingency Plan, 310 CMR 40.0000, should an LSP Opinion rendered pursuant to Obligation (i) conclude that future site uses and activities, including exposures associated with future building construction and occupation, are inconsistent with maintaining a condition of No Significant Risk.

Any person interested in obtaining additional information or reviewing the Notice of Activity and Use Limitation and the disposal site file may contact Mr. John Oldham, Reichhold, Inc., P.O. Box 13582 Research Triangle Park, NC 27709 or at telephone number (919) 990-7789.

LSP:

COMMONWEALTH OF MASSACHUSETTS
JOHN D. RENDALL No. 9416
REGISTERED
LICENSED SITE PROFESSIONAL

1.31.2013

Mr. John D. Rendall, LSP, Licensed Site Professional

Exhibit D - Documentation of Signatory Authority

REICHHOLD

REICHHOLD, INC.

INCUMBENCY AND AUTHORITY CERTIFICATE

I, Roger L. Willis, Chief Financial Officer and Treasurer REICHHOLD, Inc. a corporation validly organized and existing under the laws of the State of Delaware (the "Company"). DO HEREBY CERTIFY that:

1. John Oldham is the Director of Site Remediation of the Company, duly appointed and qualified by the Company, and authorized to execute documents and instruments on behalf of the Company;
2. Pursuant to authority granted in the Bylaws of the Company and by the Authority Limitations, a Director shall have the power to execute all bonds, mortgages, contracts and any other instruments of the Company, and including specifically the authority to negotiate and conclude Safety, Health & Environment agreements with appropriate authorities; and
3. John Oldham, as a Director of the Company, has appropriate authority to sign the Notice Activity and Use Limitation Agreement - Parcel I Former Manufacturing Area (MA DEP RTN 3-0208).

WITNESS my hand and seal this 14th day of December, 2012.

REICHHOLD INC.

By Roger L. Willis
Roger L. Willis

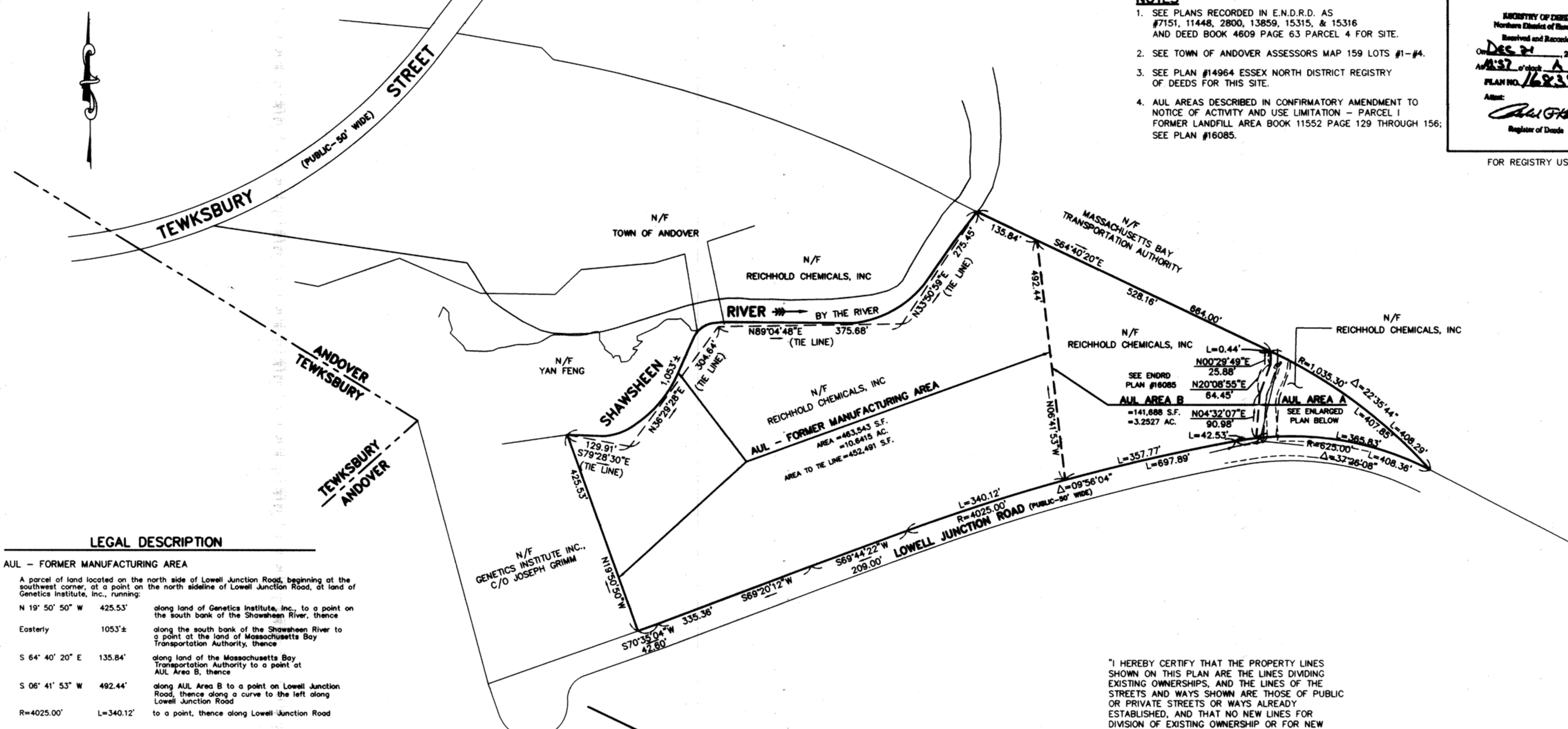
Seal

NOTES

1. SEE PLANS RECORDED IN E.N.D.R.D. AS #7151, 11448, 2800, 13859, 15315, & 15316 AND DEED BOOK 4609 PAGE 63 PARCEL 4 FOR SITE.
2. SEE TOWN OF ANDOVER ASSESSORS MAP 159 LOTS #1–#4.
3. SEE PLAN #14964 ESSEX NORTH DISTRICT REGISTRY OF DEEDS FOR THIS SITE.
4. AUL AREAS DESCRIBED IN CONFIRMATORY AMENDMENT TO NOTICE OF ACTIVITY AND USE LIMITATION – PARCEL I FORMER LANDFILL AREA BOOK 11552 PAGE 129 THROUGH 156; SEE PLAN #16085.

REGISTRY OF DEEDS
Northern District of Essex SS
Received and Recorded
On Dec 21, 2012
At 11:57 o'clock A m.
PLAN NO. 16838
Attest:
Register of Deeds

FOR REGISTRY USE



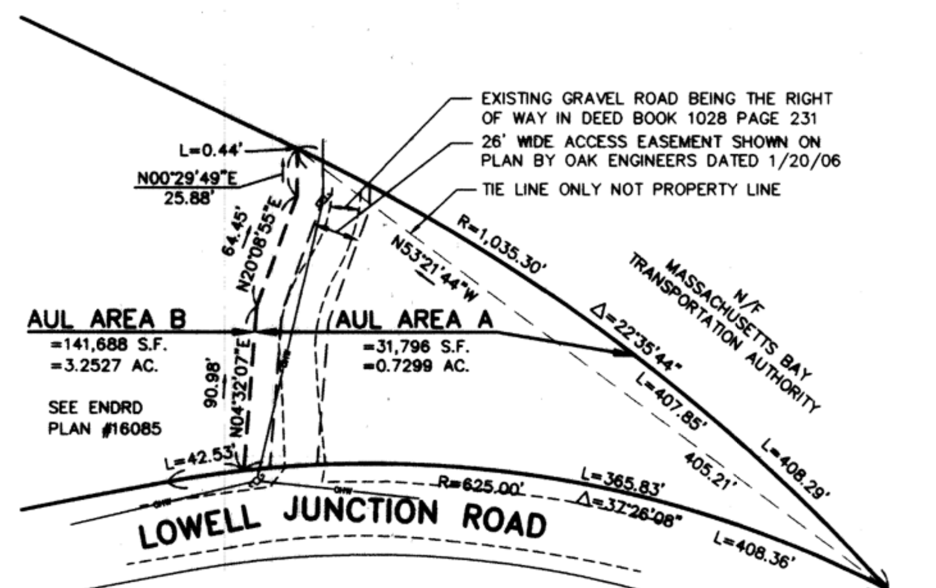
LEGAL DESCRIPTION

AUL – FORMER MANUFACTURING AREA

A parcel of land located on the north side of Lowell Junction Road, beginning at the southwest corner, at a point on the north sideline of Lowell Junction Road, at land of Genetics Institute, Inc., running:

N 19° 50' 50" W	425.53'	along land of Genetics Institute, Inc., to a point on the south bank of the Shawsheen River, thence
Easterly	1053'±	along the south bank of the Shawsheen River to a point at the land of Massachusetts Bay Transportation Authority, thence
S 64° 40' 20" E	135.84'	along land of the Massachusetts Bay Transportation Authority to a point at AUL Area B, thence
S 06° 41' 53" W	492.44'	along AUL Area B to a point on Lowell Junction Road, thence along a curve to the left along Lowell Junction Road
R=4025.00'	L=340.12'	to a point, thence along Lowell Junction Road
S 69° 44' 22" W	209.00'	to a point, thence along Lowell Junction Road
S 69° 20' 12" W	335.36'	to a point, thence along Lowell Junction Road
S 70° 35' 04" W	42.60'	to a point at land of Genetics Institute, Inc. said point being the point of beginning.

Said parcel contains 463,543 square feet or 10.6415 acres of land area and is shown as AUL–FORMER MANUFACTURING AREA on PLAN OF AUL–FORMER MANUFACTURING AREA in Andover, Massachusetts prepared for Reichhold Chemicals, Inc. Date December 4, 2012 Scale 1"=100' by Merrimack Engineering Services, Inc., 66 Park Street, Andover, MA 01810.



ENLARGED PLAN
SCALE 1"=50'

"I HEREBY CERTIFY THAT THE PROPERTY LINES SHOWN ON THIS PLAN ARE THE LINES DIVIDING EXISTING OWNERSHIPS, AND THE LINES OF THE STREETS AND WAYS SHOWN ARE THOSE OF PUBLIC OR PRIVATE STREETS OR WAYS ALREADY ESTABLISHED, AND THAT NO NEW LINES FOR DIVISION OF EXISTING OWNERSHIP OR FOR NEW WAYS ARE SHOWN AND THIS PLAN CONFORMS TO THE RULES AND REGULATIONS OF THE REGISTRY OF DEEDS."

STEPHEN E. STAPINSKI R.L.S. 12/17/12 DATE

PLAN OF AUL–FORMER MANUFACTURING AREA

IN

ANDOVER, MASSACHUSETTS

PREPARED FOR

REICHHOLD CHEMICALS, INC.

DATE: DECEMBER 17, 2012

SCALE: 1"=100' 0' 50' 100' 200' 300'
1"=50' 0' 25' 50' 100' 150'

COMMONWEALTH OF MASSACHUSETTS STEPHEN E. STAPINSKI #29875

MERRIMACK ENGINEERING SERVICES
66 PARK STREET
ANDOVER, MASSACHUSETTS 01810

16838

X:\R14 2008\DWGS\7319-01\AUL\731901AUL02.DWG 12/17/12

Attachment E - Data Usability Evaluation

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2006 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed by one or more of the following methods: Volatiles by SW-846 8260B, Phenolic acids by SW-846 8270C, Methane by RSK-175, Total Organic Carbon by EPA 415.1, Formaldehyde by EPA 8315A Metals by SW-846 6010, Alkalinity by EPA 310.1, Nitrate by EPA 300.0, Sulfate by EPA 300.0, and Sulfide by EPA 376.1.

SDGs from 2006 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of “yes” or “no” questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, and C were designated “yes” (or N/A). In some cases, questions D and/or E were designated “no”, but an affirmative response to questions D and E is not required for “presumptive certainty” status.

This data quality review pertains only to samples used in the human health risk assessment addendum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

57960 (December, 2006):

Volatiles:

The case narrative noted that the laboratory control sample duplicate (L812156B2) had recoveries for Chloromethane and Trichlorofluoromethane outside the laboratory acceptance criteria but within the MCP CAM acceptance criteria, therefore this is not expected to have an effect on the quality of data.. The MS/MSD analyzed on sample (CHMW-9) had recoveries outside the acceptance criteria for tert-Butylbenzene, n-butyl benezene, and 1,2,4-Trimethylbenezene. Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

Phenolic Acids:

There were no issues noted in the case narrative for this fraction of this SDG.

Total Organic Compound:

There were no issues noted in the case narrative for this fraction of this SDG.

57965 (December, 2006):

Volatiles:

The case narrative noted that sample GP-17, GP-16, and GP-16D did not have Ethylbenezene results reported below the quantitation limits due to it's presence in the labatory blank below the quanatation limits. Results above the quantitation limit were reported without qualification. The laboratory control sample duplicates (L812156B2) had recoveries for Chloromethane and Trichlorofluoromethane, (L812156B4) had recoveries for Dichlorodifluoromethane and Chloromethane, and (L812186B4) had recovery for Chloromethane, all outside the laboratory acceptance criteria but within the MCP CAM acceptance criteria, therefore this is not expected to have an effect on the quality of data.. The MS/MSD analyzed on sample (CHMW-9) had recoveries outside the acceptance criteria for tert-Butylbenzene, n-butyl benezene, and 1,2,4-Trimethylbenezene. Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

Phenolic Acids:

The case narrative noted that Phenol had low recovery in the MS analyzed on sample (CHMW-9). Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

Methane:

The case narrative noted that the MS/MSD analyzed on sample (CHMW-9) did not meet acceptance criteria for Methane due to high concentrations of Methane in sample. Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

Total Organic Compound:

There were no issues noted in the case narrative for this fraction of this SDG.

Metals:

There were no issues noted in the case narrative for this fraction of this SDG.

Wet Chemistry:

There were no issues noted in the case narrative for this fraction of this SDG.

57977 (December 2006):

Volatiles:

The case narrative noted that sample GP-20, GP-09, and GP-18D did not have Ethylbenezene results reported below the quantitation limits due to it's presence in the labatory blank below the quanatation limits. Results above the quantitation limit were reported without qualification. The laboratory control sample duplicates (L812156B2) had recoveries for Chloromethane and Trichlorofluoromethane, (L812156B4) had recoveries for Dichlorodifluoromethane and Chloromethane, and (L812186B4) had recovery for Chloromethane, all outside the laboratory acceptance criteria but within the MCP CAM acceptance criteria, therefore this is not expected to have an effect on the quality of data.. The MS/MSD analyzed on sample (CHMW-9) had recoveries outside the acceptance criteria for tert-Butylbenzene, n-butyl benezene, and 1,2,4-Trimethylbenezene. Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

<u>Phenolic Acids:</u>

The case narrative noted that Phenol had low recovery in the MS analyzed on sample (CHMW-9). Data are not qualified based on MS/MSD exceedances alone, and the laboratory control sample was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data.

<u>TOC:</u>
There were no issues noted in the case narrative for these fractions of this SDG.

Conclusion:

Some results would likely be designated "estimated" during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, "estimated" results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated "biased low" or "biased high" during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when "biased low" results are less than the project action limit and when "biased high" results are greater than the project action limit. Some reanalysis results were designated "biased extremely low" and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte's project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2007 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed by one or more of the following methods: Volatiles by SW-846 8260B, Semi-volatile componds by SW-846 8270C, Metals by SW-846 6010B, Volatile Petroleum Hydrocarbons (VPH) by MADEP VPH Method Rev 1.1, Extracatable Petroleum Hydrocarbon (EPH) by MADEP VPH Method Rev 1.1, Total Organic Carbon by SW-846 415.1.

SDGs from 2007 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of "yes" or "no" questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, C, and D were designated "yes" (or N/A). In some cases, questions E and/or F were designated "no", but an affirmative response to questions E and F is not required for "presumptive certainty" status.

This data quality review pertains only to samples used in the human health risk assessment addedndum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

58597 (April 2007):

<u>Volatiles:</u>
The case narrative indicated that some volatiles results were characterized by elevated reporting limits as a result of dilution. The data user must examine whether the raised RL is higher than that analyte's project action limit, but in most cases, dilutions result from elevated concentrations of compounds.

The case narrative noted that recovery for some compounds exceeded the upper control limit in the matrix spike/matrix spike duplicate pair. Because acceptable LCS recovery was demonstrated for these compounds, any difficulties in the detection or quantification of these compounds is likely related to matrix effects. This QC exceedance is not expected to affect the data quality.

The case narrative noted that vinyl chloride and dichlorodifluoromethane exceeded the labatory acceptance criteria in the laboratory control sample. These analytes were not detected in any samples for this SDG and results were reported without qualification.

Semivolatiles:
The case narrative indicated that some semivolatiles results were characterized by elevated reporting limits as a result of matrix spike and matrix spike duplicate interference. The data user must examine whether the raised RL is higher than that analyte's project action limit.

The case narrative noted that the analyte dimethyl phthalate had low recovery in the laboratory control sample. Low LCS recovery demonstrates difficulty in the detection and quantification of these compounds in related samples. Detects for dimethyl phthalate should be considered "estimated" and "biased low". Nondetects for dimethyl phthalate should be considered "nondetect, estimated reporting limit".

The case narrative noted that acetophenone had high recovery in the laboratory control sample. High LCS recovery demonstrates a possible high bias for this compound in related samples. Detects for acetophenone should be considered "estimated" and "biased high".

VPH:
The case narrative noted that 2,2,4-Trimethylpentane exceeded the upper control limit in the laboratory control sample. High LCS recovery was noted for 2,2,4-Trimethylpentane in the MS/MSD. High LCS recovery demonstrates a possible high bias for this compound in related samples. Detects for 2,2,4-Trimethylpentane should be considered "estimated" and "biased high".

EPH:

The case narrative noted that labatory control sample duplicate had low recovery for C9 and C10. The ranges were in control. Results were reported without qualifaction.

58621 (April 2007):

Volatiles:
The case narrative noted that the MS was characterized by recovery values outside of control limits. Data are not qualified based on MS/MSD exceedances alone, and the LCS was characterized by acceptable recovery for these compounds; therefore this is not expected to have an effect on the quality of data. The LCS was characterized by high exceedances for dichlorodifluoromethane and vinyl chloride. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

Semivolatiles:
There were no issues noted in the case narrative for these fractions of this SDG.

VPH:
The case narrative noted that 2,2,4-Trimethylpentane had a high recovery in th MS/MSD. High LCS recovery demonstrates a possible high bias for this compound in related samples. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

58674 (May 2007):

Volatiles:

The case narrative indicated bromomethane had low recovery in the labatory control sample. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

Phenolic acids:
The case narrative indicated phenol and 4-nitrophenol had low percent recoveries in the labatory control sample. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data

Total Organic Compound:
There were no issues noted in the case narrative for these fractions of this SDG.

58675 (May 2007):

Volatiles:

The case narrative indicated bromomethane had low recovery in the labatory control sample. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

Semivolatiles:
Phenol and 4-Nitrophenol had low percent recoveries in laboratory control samples. The analytes were not detected in this SDG and results were reported without qualification.

VPH:
There were no issues noted in the case narrative for these fractions of this SDG.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

58684 (May 2007):

Volatiles:

The case narrative indicated bromomethane had low recovery in the labatory control sample. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

The case narrative indicated Dichlorodifluoromethane had recovery above the acceptance criteria in laboratory control sample. The laboratory control sample duplicate was in control for all analytes. Results were reported without qualification.

Semivolatiles:
The case narrative indicated Phenol and 4-Nitrophenol had low percent recoveries in laboratory control samples. The analytes were not detected in this SDG and results were reported without qualification.

The case narrative indicated d12-Perylene had low recovery of internal standard. The sample was reanalyzed with similar results. No target analytes were associated with internal standard d12-Perylene. Results were reported with a comment concerning the low internal standard recovery.

VPH:
There were no issues noted in the case narrative for these fractions of this SDG.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

58973 (June 2007):

Volatiles:

The case narrative indicated the laboratory control sample analyzed had recovery above the acceptance criteria for Methylene chloride. All related samples are nondetect; therefore this is not expected to have an effect on the quality of data.

The case narrative indicated Dichlorodifluoromethane had recovery above the acceptance criteria in laboratory control sample. The laboratory control sample duplicate was in control for all analytes. Results were reported without qualification.

The case narrative indicated that due to presence of high concentration of analytes sample (SED2-CH12) was only analyzed as a methonal extract. The sample was also submitted for MS/MSD but the laboratory was unable to run it as a required dilution.

Semivolatiles:
The case narrative indicated some analytes had recoveries outside the laboratory acceptance criteria in the MS/MSD analyzed on sample (SED2-CH12) due to concentrations of these analytes in the sample. The laboratory control samples were in control for all analytes. Results were reported without qualification.

VPH:

The case narrative indicated ethylbenzene and xylenes had recoveries outside the laboratory acceptance criteria in the MS/MSD analyzed on sample (SED2-CH12). The laboratory control samples were in control for all analytes.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

58974 (June 2007):

Volatiles:

The case narrative indicated several analytes had RPDs above acceptance criteria in the laboratory control samples. M+p-Xylene had high RPD in the MS/MSD analyzed on sample (SW2-CH12). Results were reported without qualification.

Semivolatiles:
The case narrative indicated the labatory control sample duplicate had low recovery and a high RPD for 2,4-Dinitrophenol. The MS/MSD analyzed on sample (SW2-CH12) had low recovery for Phenol. Results were reported without qualification.

VPH:
There were no issues noted in the case narrative for these fractions of this SDG.

EPH:

The case narrative indicated the laboratory control samples had low recovery for C9 and C10. The ranges were in control. C10 had a low recovery in the MS/MSD analyzed on sample (SW2-CH12). Results were reported without qualification.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

59253 (July 2007):

Volatiles:

The case narrative indicated (DUP 3-TP) had a high recovery for bromofluorobenzene surrogate. The sample was reanalyzed with similar results. Results were reported with a comment to this affect.

The case narrative indicated dichlorodifluoromethane had %D outside the acceptance criteria in the continuing calibration standard. The laboratory control sample had recoveries outside the laboratory acceptance criteria for chloromethane and vinyl chloride. The laboratory control sample was reanalyzed with all analytes in control except chloromethane. The MS/MSD analyzed on sample (TP-3-US) had several analytes with recoveries and RPDs outside the laboratory acceptance criteria due to matrix affect.

The case narrative indicated the laboratory control sample duplicate analyzed had marginally low recovery for chloromethane and methylene chloride. The laboratory control sample was in control for all analytes. Results were reported without qualification.

Semivolatiles:
The case narrative indicated the laboratory control and the laboratory control sample duplicate had low recovery for 2,4-Dinitrophenol. The MS/MSD analyzed on sample (TP-1-0-2) had low recovery for 2,4-Dinitrophenol. Results were reported with a comment that 2,4-Dinitrophenol did not meet acceptance criteria.

VPH:
The case narrative indicated the MS/MSD on sample (TP-3-US) did not meet acceptance criteria for some analytes due to matrix affect. The laboratory control samples were in

control for all analytes. Results were reported without qualification. The MSD had low surrogate recoveries.

EPH:

The case narrative indicated the laboratory control samples had low recovery for benzo(g,h,i) perylene in the MSD. The laboratory control samples for the batch were in control for all analytes and results were reported without qualification.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

59885 (October 2007):

Volatiles:

cated chloromethane had %D outside the acceptance criteria in the continuing calibration standard. The laboratory control sample was in control for all target analytes. Results were reported without qualification.

Semivolatiles:
There were no issues noted in the case narrative for these fractions of this SDG.

Total Organic Compound:
There were no issues noted in the case narrative for these fractions of this SDG.

60087 (October 2007):

Volatiles:

The case narrative indicated the laboratory control sample duplicate analyzed had a high recovery for tetrachlroethene. The laboratory control sample was in control for all analytes. Several analytes had recoveries outside the laboratory acceptance criteria in the MS/MSD analyzed on sample (CP-TF-Stain) due to matrix affect. The laboratory control samples were in control excepted as stated above. Results were reported without qualification.

Semivolatiles:
The case narrative indicated all sample on this SDG had low acid surrogate recoveries due to sample matrix affect. The samples were re-extracted and confirmed the orginial results. The results of both analysis were reported with a comment to this affect.The MS/MSD (CP-Garage) had several analytes with recoveries outside the laboratory acceptance criteria. The laboratory control samples were in control for all analytes. Results were reported without qualification.

VPH:
The case narrative indicated the laboratory control sample duplicate had high recovery for pentane. The laboratory control sample was in control for all analytes. Results were reported without qualification.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

60512 (October 2007):

Metals:
There were no issues noted in the case narrative for these fractions of this SDG.

Conclusion:

Some results would likely be designated “estimated” during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, “estimated” results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated “biased low” or “biased high” during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when “biased low” results are less than the project action limit and when “biased high” results are greater than the project action limit. Some reanalysis results were designated “biased extremely low” and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte’s project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2008 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed by one or more of the following methods: Volatiles by SW-846 8260B, Semi-volatile componds by SW-846 8270C, Volatile Petroleum Hydrocarbons (VPH) by MADEP VPH Method Rev 1.1,Total Organic Carbon by SW-846 415.1.

SDGs from 2008 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of "yes" or "no" questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, C, and D were designated "yes" (or N/A). In some cases, questions E and/or F were designated "no", but an affirmative response to questions E and F is not required for "presumptive certainty" status.

This data quality review pertains only to samples used in the human health risk assessment addendum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

61513 (June 2008):

Volatiles:
The case narrative indicated quantitation limits for 1,2_dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. All samples were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds. The laboratory control sample had high recovery for 1,1-dichloroethene. The MS/MSD analyzed on sample (GM-2) had recovery above the acceptance criteria for 1,1-dichloroethene, 2-hexanone, methyl isobutyl ketone and carbon disulfide. These analytes were detected in any sample associated with this QC and results were reported without qualification.

Semivolatiles:
The case narrative indicated due to method limitations, the quantitation limit for pentachlorophenol may not meet regulatory standards for aqueous samples. The laboratory control samples were in control for all target analytes. The MSD (GM-2) was low outside

the laboratory acceptance criteria by 1%. The MS had acceptable recovery. Results were reported without qualification.

TOC:
There were no issues noted in the case narrative for these fractions of this SDG.

61618 (June 2008):

Metals:
The case narrative noted that zinc failed the MS/MSD recovery criteria low. The sample concentration was greater than four times the spike concentration. The associated LCS and LCSD recovered within control limits.

The case narrative noted that samples required dilution prior to analysis. Dilution was necessary because of elevated concentrations of target compounds. The data user must examine whether the raised RL is higher than that analyte's project action limit.

62288 (September 2008):

Volatiles:

The case narrative indicated that due to ethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples.

The case narrative indicated all sample except 62288-1 and 62288-8 requires dilutions due to high concentration of target analytes. The laboratory control sample (L810018B) had high recovery of 2-hexanone.

The case narrative indicated the laboratory control sample duplicate had some analytes with high recoveries and high RPDs. The laboratory control sample was in control for all analyte recoveries. Results were reported without qualifications. Semivolatiles:
The case narrative indicated the MS/MSD on sample 62288-1 had low surrogate recoveries and low recovery of the acid compounds. Results were reported without qualification.

Total Organic Compound:
There were no issues noted in the case narrative for these fractions of this SDG.

62327 (September 2008):

Volatiles:

The case narrative indicated that due to ethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples.

The case narrative indicated sample 62327-1 required dilutions due to high concentration of target analytes. The laboratory control sample (L810018B) had high recovery of 2-hexanone. The case narrative indicated the laboratory control sample duplicate had some analytes with high recoveries and high RPDs. The laboratory control sample was in control for all analyte recoveries. Results were reported without qualifications.
Semivolatiles:
There were no issues noted in the case narrative for these fractions of this SDG.

VPH:

There were no issues noted in the case narrative for these fractions of this SDG.

EPH:

There were no issues noted in the case narrative for these fractions of this SDG.

Total Organic Compound:

There were no issues noted in the case narrative for these fractions of this SDG.

Conclusion:

Some results would likely be designated "estimated" during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, "estimated" results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated "biased low" or "biased high" during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when "biased low" results are less than the project action limit and when "biased high" results are greater than the project action limit. Some reanalysis results were designated "biased extremely low" and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte's project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2009 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed by one or more of the following methods: Volatiles by SW-846 8260B, Semi-volatile componds by SW-846 8270C, Total Organic Carbon by SW-846 415.1.

SDGs from 2009 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of “yes” or “no” questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, C, and D were designated “yes” (or N/A). In some cases, questions E and/or F were designated “no”, but an affirmative response to questions E and F is not required for “presumptive certainty” status.

This data quality review pertains only to samples used in the human health risk assessment addendum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

64021 (June 2009):

Volatiles:
The case narrative indicated quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. All samples except 65146-1 and 65146-9 were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds. The laboratory control sample had high recovery above laboratory acceptance criteria but within MCP criteria for tetrachloroethene and 2-chlorotoluene. 2-Hexanone had high recovery. Results were reported without qualification.

Semivolatiles:
The case narrative indicated due laboratory error the requested MS/MSD was not extracted on sample (CHMW-120060509). The laboratory controls samples were in control for all target analytes.

TOC:
There were no issues noted in the case narrative for these fractions of this SDG.

65146 (October 2009):

Volatiles:
The case narrative indicated quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. All samples except 65146-1 and 65146-9 were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds.

TOC:
There were no issues noted in the case narrative for these fractions of this SDG.

Conclusion:

Some results would likely be designated "estimated" during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, "estimated" results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated "biased low" or "biased high" during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when "biased low" results are less than the project action limit and when "biased high" results are greater than the project action limit. Some reanalysis results were designated "biased extremely low" and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte's project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2010 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed for: Volatiles by SW-846 8260B.

SDGs from 2010 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of "yes" or "no" questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, C, D, E, F, and G were designated "yes" (or N/A). In some cases, questions H and/or I were designated "no", but an affirmative response to questions H and I is not required for "presumptive certainty" status.

This data quality review pertains only to samples used in the human health risk assessment addendum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

67572 (August 2010):

<u>Volatiles:</u>
The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. All samples except 67572-1 and 67572-9 were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds.

68550 (December 2010)

<u>Volatiles:</u>
The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples.

The case narrative indicated that 1,3-dichlorobenzene had an average Rf of 0.469 and methyl ethyl ketone had an average Rf of 0.078. results were reported without qualification.

Conclusion:

Some results would likely be designated "estimated" during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, "estimated" results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated "biased low" or "biased high" during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when "biased low" results are less than the project action limit and when "biased high" results are greater than the project action limit. Some reanalysis results were designated "biased extremely low" and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte's project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.

Data Quality Review of Reichhold Andover Analytical Data - Former Manufacturing Area (FMA) 2011 Sampling

PREPARED FOR: Reichhold, Inc.
PREPARED BY: CH2M HILL, Inc.

DATE: November 1, 2012

For this data evaluation, the precision, accuracy, and completeness of analytical results were ascertained by reviewing laboratory case narratives. All laboratory reports were accompanied by a case narrative. Laboratory QC forms, if provided, were used to verify any QC deficiencies noted in the laboratory case narratives. Samples were analyzed for: Volatiles by SW-846 8260B.

SDGs from 2011 included a certification pertaining to the analytical procedures and associated QC criteria and performance standards for all data included in the report. This included a series of "yes" or "no" questions, followed by a statement attesting to the accuracy and completeness of those responses and of the attached laboratory report. In each case, questions A, B, C, D, E, F, and G were designated "yes" (or N/A). In some cases, questions H and/or I were designated "no", but an affirmative response to questions H and I is not required for "presumptive certainty" status.

This data quality review pertains only to samples used in the human health risk assessment addendum (HHRAA). These samples are outlined in Table D-1 of the HHRAA.

70219 (June 2011):

Volatiles:
The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. All samples except 70219-1 and 70219-9 were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds.

The case narrative indicated t-Butyl alchol, 2-hexanone, methyl isobutyl, and 1,3-dichlorobenezene did not meet minimum Rf criteria for the initial calibration, however all analytes had acceptable % results except tetrachloroethene which had a % result of 24.3% the laboratory control samples had some analytes with recoveries above the laboratory acceptance criteria but within MCP criteria. The MS/MSD analyzed on sample 70219-2 had results outside the acceptance criteria for bromomethane, chlorobenzene, and ethylbenezene. Chlorobenzene and Ethylbenezene were detected in the parent sample at levels that exceeded the calibration range of the instrument. Results were reported without qualification.

70358 (July 2011)

Volatiles:

The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples. The case narrative indicated that 1,3-dichlorobenzene did not meet Rf criteria for the initial calibration. The initial calibration verification standard was in control for all analytes.

71268 (October 2011)

Volatiles:

The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples.

The case narrative indicated that methyl ethyl ketone and 1,4-dioxane did not meet Rf criteria for the initial calibration. The initial calibration verification standard was in control for all analytes. All samples except 71268-1 and 71268-7 were characterized by elevated reporting limits as a result of dilution. Dilution was necessary because of elevated concentrations of target compounds.

71497 (November 2011)

Volatiles:

The case narrative indicated due to method limitations, the quantitation limits for 1,2-dibromoethane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,3,5-trimethylbenzene, and hexachlorobutadiene may not meet regulatory standards for aqueous samples.

The case narrative indicated that methyl ethyl ketone and 1,4-dioxane did not meet Rf criteria for the initial calibration. The initial calibration verification standard was in control for all analytes. Semple 71497-4 required dilution due to elevated concentrations of target compounds.

Conclusion:

Some results would likely be designated "estimated" during data validation as a result of QC exceedances. The estimation of results does not necessarily affect the usability of data in a negative manner. Estimated results are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks. However, "estimated" results are somewhat inaccurate and the direction of bias is not known. Therefore, the data user should exercise caution and act conservatively when estimated results are close to the project action limit.

Some results would likely be designated "biased low" or "biased high" during data validation as a result of QC exceedances. Biased results are similar to estimated results in that they are usable at their reported concentrations for evaluating the nature and extent of contamination and for estimating potentially associated human health and ecological risks.

However, these results are somewhat inaccurate, and because the direction of bias is known, the data user should exercise caution and act conservatively when "biased low" results are less than the project action limit and when "biased high" results are greater than the project action limit. Some reanalysis results were designated "biased extremely low" and should not be used because of inaccuracy. This does not necessarily affect the completeness of the dataset because the original results are available for use.

Several samples were characterized by elevated reporting limits (RLs) because of possible interference from the sample matrix. Elevated RLs also resulted from diluted analyses. The raised RLs were associated with non-detected results, and the data user must examine whether the raised RL is higher than that analyte's project action limit. Otherwise, raised RLs have no effect on the reported data for the associated samples, as the results are still usable at the elevated RL.